



Given in Loving Memory of

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# INTERNATIONAL ASPECTS OF OCEANOGRAPHY

OCEANOGRAPHIC DATA  
and  
PROVISIONS FOR OCEANOGRAPHIC RESEARCH

*By*  
THOMAS WAYLAND VAUGHAN  
AND  
OTHERS

NATIONAL ACADEMY OF SCIENCES  
WASHINGTON, D. C.  
1937

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TO THE MEMORY OF  
**WICLIFFE ROSE**  
IN RECOGNITION OF HIS INTEREST IN OCEANOGRAPHY  
AND HIS INFLUENCE IN ITS ADVANCEMENT

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## PREFACE

On April 27, 1927, the National Academy of Sciences adopted a resolution which read as follows:

THAT, "The President of the Academy be requested to appoint a Committee on Oceanography from the sections of the Academy concerned to consider the share of the United States of America in a world wide program of oceanographic research and report to the Academy."

The President of the Academy, at that time Prof. A. A. Michelsen, accordingly appointed Messrs. Wm. Bowie, E. G. Conklin, B. M. Duggar, John C. Merriam, T. Wayland Vaughan, and Frank R. Lillie (Chairman), as members of the Committee. Dr. Henry B. Bigelow, Curator of Oceanography in the Museum of Comparative Zoology, Harvard University, was engaged as Secretary. Subsequently the Committee's membership was augmented by the appointment of Messrs. Bigelow and Arthur L. Day. When Doctor Lillie became President of the Academy on July 1, 1935, Doctor Bigelow succeeded him as Chairman of the Committee.

Working in conjunction with the members of the Committee and after conferences with numerous persons and visits to oceanographic institutions, Doctor Bigelow prepared a report entitled "Oceanography, its scope, problems, and economic importance," which was published in 1931.

As a result of the efforts of the Committee the Rockefeller Foundation provided funds for the establishment of the Woods Hole Oceanographic Institution. Associated with the establishment of that Institution an effort was made to expand and stabilize the Bermuda Biological Station for Research. To this project the Rockefeller Foundation contributed £50,000, on the understanding that the Bermuda Government would contribute £5,500 and other benefits and in the expectation that the Bermuda Station would serve as an oceanic station of the Woods Hole Oceanographic Institution. Further information on this station is given in the last section of this report "Catalogue of institutions engaged in oceanographic work."

Besides the funds for oceanographic research above mentioned, the Rockefeller Foundation made a liberal contribution to the University of Washington for the erection of a laboratory building for oceanographic research and for the operation or purchase of an oceanographic research boat. This led to the establishment of the oceanographic laboratories of the University of Washington. Further information on these laboratories is given in the catalogue of oceanographic institutions.

In addition to the contributions above indicated, the Rockefeller Foundation allotted \$40,000 to assist in the erection of a second laboratory building, named Ritter Hall, on the grounds of the Scripps Institution of Oceanography, University of California, La Jolla, California. It was expected that further development would be taken care of by the University of California in conjunction with the Scripps family. The execution of the plan was interrupted by the great depression, but subsequently it has been put into

effect. A brief history of the Scripps Institution is given in the catalogue of oceanographic institutions.

Although the development of the Bingham Oceanographic Foundation at Yale was independent of the activities of the National Academy Committee on Oceanography, it should be mentioned in this connection because of the extensive coöperation between it and the Woods Hole Oceanographic Institution. The *ATLANTIS* of the Woods Hole Institution has served as the research vessel for both the Woods Hole Institution and the Bingham Oceanographic Foundation. A succinct account of the Bingham Oceanographic Foundation is included in the catalogue of oceanographic institutions.

In the hope that the United States Navy might find it feasible to extend its activities in oceanographic investigations, the members of the National Academy Committee on Oceanography called on the Secretary of the Navy, at that time the Honorable Charles Francis Adams. The conference led to the appointment of a Naval Committee on Oceanography under the chairmanship of Rear Admiral Frank H. Schofield, now retired. This Committee made several recommendations, one of which was that Naval vessels equipped with sonic-sounding apparatus should, when feasible, follow routes which would carry them over oceanic areas for which information on oceanic depths was inadequate. This recommendation was adopted and it has led to probably the most extensive systematic program of sounding for bottom configuration undertaken by any country. Since about 1928 most of the north Pacific north of a line from the California coast to the Hawaiian Islands and thence to the Philippines has been covered by a series of closely spaced lines from east to west and these lines have been crossed by other lines, north to south between the Aleutian and the Hawaiian Islands and toward the northeast from the Hawaiian Islands to Puget Sound. United States Naval vessels have also run many other lines of soundings. In addition to the soundings, the Navy Department has endeavored to assist investigations in many other fields, so that it has now become one of the world's major agencies in oceanographic research. Serial sections for subsurface temperatures and salinities, the plotting of sea surface temperatures and surface drift, and the utilization of submarines for the determination of gravity at sea are noteworthy.

The Committee also took up oceanographic investigations with the United States Coast and Geodetic Survey and the United States Coast Guard. Information on these and other governmental institutions will be found in the catalogue of oceanographic institutions to which reference has already been made.

Notwithstanding the activities above enumerated, it seemed to the members of the Committee that the purpose of the original resolution of the Committee "to consider the share of the United States of America in a world wide program of oceanographic research," had not been completely covered. Oceanography is necessarily a subject of world wide extent. The oceans form about seventy per cent of the surface of the earth and their margins are touched by most of the countries of the world. Rising from the ocean floors there are multitudes of islands, some of them large, tens or even hundreds of thousands of square miles in area, and they are under the jurisdiction of many nations. It is obvious that any comprehensive systematic investigation of the oceans must be in large measure an international enterprise. Recognizing these facts the Committee decided to attempt the preparation of a digest of the oceanographic data available for the different ocean basins and to compile a catalogue of the various institutions in the world engaged in any kind of oceanographic work.

The scope and general arrangement of the present report was decided upon at various meetings of the Committee on Oceanography. As regards oceanographic information on the different ocean basins, the purpose was to present in succinct form the degree of exploration of as nearly all the areas of the oceans as is possible. The topics covered by the report need not be listed here, but as an illustration of what was intended the chart showing the available data on subsurface salinities and temperatures in the Indian Ocean may be taken. It is immediately obvious that there are no records in an area between  $10^{\circ}$  and  $30^{\circ}$  south latitude and between  $70^{\circ}$  and  $90^{\circ}$  east longitude. That is, there is here an area twenty degrees of latitude on one side and twenty degrees of longitude on the other side for which there is not a single vertical section for subsurface temperatures and salinities. There are in the Indian Ocean other areas ten degrees of latitude and ten degrees of longitude on a side within which no observations have been made. The report was intended to bring out in this way those areas in the different oceans on which there is no information. It should, therefore, serve as a guide for oceanographic research on many important oceanographic problems, especially those that deal with the geophysical aspects of oceanography.

The catalogue of oceanographic institutions was intended to show for each country the provisions in it for oceanographic research and the scope of its oceanographic activities. In this way just what was being done in each country would be made obvious, and those countries, in which the provisions are inadequate, should they desire to do so, may utilize the information for placing their programs in oceanography on a plane similar to that of other countries.

The Committee commissioned Thomas Wayland Vaughan to prepare a report of the kind indicated. On the first of September in 1932 he started on a trip around the world to visit various oceanographic institutions and to consult with the oceanographers in as many different countries as possible. After leaving the United States he went first to England, thence to Norway, Sweden, Denmark, Germany, the Netherlands, France, Spain, Monaco, Italy, Egypt, Siam, French Indo China, China, the Philippines, Japan, and the Hawaiian Islands. On previous trips Mr. Vaughan had been in New Zealand, Australia, the East Indies, and the Malay Peninsula, largely for the purpose of getting information on oceanographic activities. Subsequent to his journey around the world he visited oceanographic institutions along the Pacific coast of Canada and the United States, the two marine laboratories in Scotland, and he either conferred with the directors of or visited other oceanographic institutions in eastern Canada and the United States.

By the spring of 1934 the report had far advanced toward completion but in June, 1934, Mr. Vaughan was taken ill and was unable to resume work on the report until after he retired from the Directorship of the Scripps Institution of Oceanography at the end of August, 1936. During September he attended the meeting of the International Association of Physical Oceanography in Edinburgh and inspected marine laboratories in Scotland. After his return to the United States, from the first part of November, 1936, he gave the completion of the report his uninterrupted attention until it was ready for press.



## ACKNOWLEDGMENTS

A report such as this is necessarily a coöperative enterprise. Information is taken not only from various publications but a great deal of it, perhaps most of it, has been contributed by persons sympathetic with the purpose of the work. On the trip around the world and on other visits to oceanographic institutions, everywhere the attitude was that of sympathetic helpfulness. The governmental officials, the chiefs and the other members of the staffs of oceanographic institutions, and the members of the faculties of the various universities did everything possible to supply desired information. An imperfect list of those from whom assistance was received on the journey around the world contains the names of fully one hundred persons. These are thanked without listing individual names but the names of those who have contributed to the report, either sections or manuscript data, will be recorded.

Prof. Harald U. Sverdrup, formerly of the Michelsen Institute in Bergen, Norway, and now the Director of the Scripps Institution of Oceanography at La Jolla, California, and Prof. B. Helland-Hansen, Director of the Geophysical Institute in Bergen, Norway, have prepared the section of the report entitled "Oceanographic Data, Vertical Sections of Temperature and Salinity for the Norwegian Sea, the Polar Sea, and Adjacent Areas." Much help was received from Prof. A. Defant, Director, and Prof. Georg Wüst, both of the Institut für Meereskunde, Berlin, Germany. Professor Defant gave permission to use as base charts the charts published by him in his paper entitled "Systematische Erforschung des Weltmeeres," and he also gave permission to use the text and charts to illustrate the section of this report by Professor Wüst on "Horizontal Distribution of Temperature, Salinity, and Density at Standard Depths in the Atlantic Ocean." Professor Wüst consented to the use of this material and to the translation of the pages of text that accompany the four charts. Messrs. C. O. Iselin and A. E. Parr compiled on a chart the oceanographic stations occupied in the Caribbean Sea and the Gulf of Mexico by the MABEL TAYLOR and ATLANTIS. Manuscript information was supplied by Dr. Stanley Kemp and Dr. N. A. Mackintosh on the stations occupied by DISCOVERY II and WM. SCORESBY. Sir Douglas Mawson supplied information on the stations occupied by the DISCOVERY I. Messrs. Håkon Mosby and J. K. Eggvin of the Geophysical Institute, Bergen, Norway, contributed a list of the stations occupied around Antarctica by the Norwegian ship NORWEGIA. Mrs. Johannes Schmidt and Mr. Helge Thomsen gave information on the stations occupied by the DANA during its circumnavigation of the globe in 1928-29. Dr. T. G. Thompson supplied lists of stations occupied in the north Pacific by the CATALYST. Many manuscript records were received from the United States Hydrographic Office and the Scripps Institution of Oceanography. Colonel R. B. Seymour Sewell supplied information on the stations occupied by the MABAHISS in the Indian Ocean and Dr. C. Crossland prepared a long manuscript list of stations occupied by the same vessel in the Red Sea.

Dr. C. S. Piggot of the Geophysical Laboratory of the Carnegie Institution of Wash-

ganisms and the water. Available data on vertical sections of temperature and salinity for the different ocean basins, the basic data for the treatment of the dynamics of the movements of the water masses, are presented in the section of this report following this Introduction. There is also, on subsequent pages, a short statement on available tidal records. The only information on biological data is contained in the catalogue of institutions. It would have been desirable to catalogue the available data on oxygen content, the minimum oxygen layer, and the CO<sub>2</sub>-content of seawater, chemical relations largely controlled by organic activity in conjunction with circulation, but to do so was impracticable.

2. The study of the interaction of the sea and the atmosphere; solar radiation and its penetration into seawater. Except to indicate data on temperature and salinity and to catalogue institutions engaged on researches in marine meteorology, this complex of subjects is not specially considered in this volume. Here may be noted only some geophysical and biological commonplaces. It is generally known that the engine that drives the atmospheric and oceanic circulations is the Sun, and the engine that actuates life on the earth, through its making photosynthesis possible, is the Sun. On the circulation of the atmosphere and of the waters in the oceans, the rotation of the earth on its axis has a directing influence. Any changes in density of seawater take place only at the sea surface by heating or cooling, by precipitation or evaporation. Below the surface, the changes are by the mixing of water masses of different densities. Winds blowing over the surface of the sea produce surface currents which may uphold an abnormal distribution of density. The characteristics of the contact zone between the atmosphere and the sea surface are of great importance. Any change in the velocity of the wind over the surface results in a change in the velocity of the surface currents. Since water possesses great heat capacity, ocean currents cause the transfer of large quantities of heat. A change in the velocity of an ocean current, due to a change in atmospheric circulation, may later influence meteorological conditions in a remote region. This concept may be of value in long range weather forecasting, for one of the principles utilized in such forecasts is that of the time lag between changes in oceanic phenomena and the corresponding change in atmospheric conditions. Correlations of the kind indicated have been established in some parts of the earth, as in western Norway. The depth of penetration of light into sea water controls the depth to which plants may thrive in the sea.

It would be desirable to present synopsis of information available on these topics, but that could not be done for this report.

3. The study of the ocean-bottom—its configuration, the material on its surface, and the material that lies below it. The present state of knowledge of the configuration of the sea-floor is indicated by five charts; notes are made on the latest studies of marine bottom deposits; the results of studies of gravity at sea are contained in a chapter on that subject; a summary of present knowledge of submarine earthquake epicenters is given on three charts, there is a map showing the positions of the seismological stations of the world, and there is a brief discussion of the structure of the ocean basin as indicated by seismological data, accompanied by a map of deep-focus earthquake epicenters; and finally there is a chapter on the magnetic survey of the oceans. The summary discussions of these aspects of the oceans are comprehensive and indicate how far knowledge of them has advanced.

A statement should now be made regarding those topics that are not discussed in detail in this report, except in so far as they have already been mentioned and in so far as they are considered in the catalogue of institutions engaged in oceanographic work. They are the biological aspects of oceanography, including fisheries, the interaction between the atmosphere and the ocean, and the penetration of solar radiation into the sea. The emphasis of the report is on the geophysical aspects of oceanography, but with only subordinate consideration of marine meteorology and solar radiation, two very important subjects.

It has already been said more than once that the purpose of this volume is to present synopses of information available for the study of several aspects of the oceans. Only a few interpretations of data are here attempted, but the ultimate object is interpretation toward which the cataloging of data is only a step, while the catalogue of institutions merely shows the agencies concerned with collecting and interpreting data. Although there are no interpretations of most of the data, it is pertinent to include some references to literature in addition to those in the lists of sources of data.

Two publications on oceanographic expeditions by Rafael de Buen, the second a revised edition of the first, are as follows:

de Buen, Rafael, *Lista cronológica de las campañas y navegaciones a las que se deben observaciones científicas de carácter oceanográfico*: Consejo Oceanog. Ibero-Amer., Mem., no. 5, pp. 62, 1930.

de Buen, Rafael, *Liste chronologique des croisières océanographiques*: Com. internat. Expl. Sci. Mer Medit., Man. Observ. océanog. à la Mer, vol. 1, pp. 73, 1934.

Gerhard Schott in his "Geographie des Atlantischen Ozeans" (1926) gives a history of the voyages of discovery in the Atlantic Ocean (pp. 1–20) and an account of investigations of the Atlantic up to the end of 1925 (pp. 21–39). Since 1926 there has been a great deal of additional research on the Atlantic. The names of the principal expeditions are given in the lists of sources of the data plotted on the charts of stations occupied for vertical sections of temperature and salinity, and there are references to the latest most important literature on the dynamical oceanography of the Atlantic.

Schott in his volume "Geographie des Indischen und Stillen Ozeans" (1935) has given, in the same way as in his volume on the Atlantic, an account of the voyages of exploration in the Pacific (pp. 1–15), and of the researches prosecuted on those two oceans (pp. 16–31).

In each of the volumes by Schott there are extensive lists of publications, making it possible for the reader to go to the sources from which he took his data.

Another publication worthy of mention is the volume, "Oceanography," published as volume five of the "Physics of the Earth" by the United States National Research Council in 1932. The contents of this volume are as follows:

Introduction:

\* Introduction: The domain of oceanography. N. H. Heck.

Bottom of the Ocean:

\* Configuration of the oceanic basins. G. W. Littlehales.

Deep-sea deposits. Leon W. Collet.

Properties of Sea Water:

\* Physical properties of sea water. Thomas G. Thompson.

\* Chemistry of the sea. Thomas G. Thompson and Rex J. Robinson.

## Movements of Sea Water:

- \* The waves of the sea. R. S. Patton and H. A. Marmer.
- \* Tides and tidal currents. H. A. Marmer.
- \* A summary of basic principles underlying modern methods of dynamical oceanography. George F. McEwen.
- \* A survey of present knowledge of oceanic circulation based upon modern physical and chemical observations. Arnold Schumacher.
- \* Ice in the sea. Edward H. Smith.

## Oceanographic Instruments:

- \* Oceanographic instruments and methods. Floyd M. Soule.
- Additional oceanographic instruments. W. E. Parker.
- Deep sea bottom samplers. C. O. Iselin.

## Relations of Oceanography to Other Sciences:

- \* Oceanography and meteorology. Charles F. Brooks.
- Relation of biology to oceanography. A. G. Huntsman.
- \* The periodicity of oceanic spreading, mountain-marking, and paleogeography. Charles Schuchert.

## Index.

The chapters that contain bibliographies are marked with asterisks. Some of the bibliographies are extensive, containing references to the most important literature up to the end of 1931.

Other references to literature will be found in the reports now appearing on many expeditions, such as those of the METEOR, DISCOVERY II and WILLIAM SCORESBY, DISCOVERY I, WILLEBRORD SNELLIUS, ATLANTIS, CARNEGIE, MABAHISS, et cetera. To give lists of the parts of all these reports would require too much space. For those who wish to do so, by combining the references contained in the publications above listed or indicated, with the hundreds of citations on later pages of this volume, a fairly comprehensive bibliography of oceanographic literature can be compiled.

Abstracts and lists of current oceanographic literature are contained in the *Journal du Conseil permanent international pour l'Exploration de la Mer*, published in Copenhagen, and in the *Hydrographic Review*, published by the International Hydrographic Bureau in Monaco. Complete lists of Japanese publications on oceanography are given in *Records of Oceanographic Works in Japan*, published by the National Research Council of Japan, Tokyo. The Italian delegation of the *Commission pour l'Exploration Scientifique de la Méditerranée* has published since 1928 a series entitled *Bibliographia Oceanographica*, in which most current oceanographic literature is listed.

Many periodicals, such as the *Geographical Review*, published by the American Geographical Society, and the *Geographical Journal*, published by the Royal Geographical Society, contain reviews, and there are many notices in the *Annalen der Hydrographie und maritimen Meteorologie*, published by the Deutsche Seewarte. Records of much of the oceanographic activities in the United States are to be found in the *Transactions of the American Geophysical Union, Section of Oceanography*, published by the United States National Research Council. The triennial report of the International Committee on the Oceanography of the Pacific, under the auspices of the Pacific Science Association, gave summaries of oceanographic activities in the Pacific for the periods 1926-1929<sup>1</sup>

<sup>1</sup> Vaughan, T. Wayland, Reports of the International Committees on the Oceanography and the Coral Reefs of the Pacific: Fourth Pacific Sci. Cong., Java, 1929, Proc., vol. 1, pp. 136, Batavia, 1930.

and 1929–1933.<sup>2</sup> For the seven years covered by the reports they give a comprehensive account of oceanographic activities in the Pacific. It was hoped that the work of that Committee as a stimulating and coördinating agency for oceanographic research in the Pacific would continue, but the future of the Pacific Science Association is doubtful. The functioning of that Committee as an independent organization deserves consideration.

In the catalogue of institutions engaged in oceanographic research the provisions for the publication of scientific results are given at the end of the account of each institution whenever the desired information could be procured. By utilizing these suggestions, it is possible to obtain references to most of the current literature on oceanographic subjects.

<sup>2</sup> Vaughan, T. Wayland, International Committee on the Oceanography of the Pacific—Report of the Chairman: Fifth Pacific Sci. Cong., Victoria and Vancouver, 1933, Proc. vol. 1. pp. 245–384, 1934.



**SERIAL SECTIONS OF TEMPERATURE AND SALINITY IN  
THE DIFFERENT OCEAN BASINS**



## GENERAL DISCUSSION

Just when the concept of the unity of all oceans originated is not easy to ascertain. As soon as it was recognized that the cold water in the depths of the oceans had to come from Polar regions and that the renewal of the supply of water in those regions had to come from other latitudes, the idea of a world ocean was born, and research was directed toward both the circulation within and the exchange of water between the different ocean basins. Apparently the first one to undertake comprehensive investigations in a systematic way was Alfred Merz, who as long ago as 1922 initiated a card catalogue of all hydrographic observations in all three oceans.<sup>1</sup> These compilations were utilized in the preparation of several articles by Wüst on both the Atlantic and Pacific Oceans and one entitled "Meridionale Schichtung und Tiefenzirkulation in den Westhälften der drei Ozeane,"<sup>2</sup> and another by Lotte Möller on the Indian Ocean. Defant in a paper, "Die systematische Erforschung des Weltmeeres,"<sup>3</sup> published four charts, two for the Atlantic, one for the Pacific, and one for the Indian Ocean, on which were shown the positions of the stations at which vertical sections of temperature and salinity were made in depths of 1,000 meters and in depths of 3,000 and more meters, according to records available at the Institut für Meereskunde up to February 1, 1928, and he published lists of the sources of the data. This chapter of the present volumes may be regarded as an extension of the work initiated by Merz, but several areas not covered by the charts published by Defant have been added, viz., the Norwegian, the Polar, and adjacent seas, the Mediterranean Sea, the Gulf of Mexico and the Caribbean Sea, and the Red Sea. For various reasons it was decided to omit the Bosphorus and the Dardanelles and the Black Sea.

Regarding the Bosphorus and Dardanelles, it will be said that the Institut für Meereskunde in Berlin published in April 1928 "Alfred Merz Hydro-

graphische Untersuchungen in Bosphorus und Dardanellen," bearbeitet von Lotte Möller; Inst. Meeresk. Veröffentl. Neue Folg., A., Geogr. naturwiss. Rhe., Heft 18. There are 284 pages of text and a folio atlas of sixteen lithographed plates. Merz made two expeditions himself, 1917 and 1918, and he utilized the observations of others. Before his death he had done much toward putting the results into form for publication, but he did not complete his manuscript. Professor Möller finished the report, and it was presented to the Gesellschaft für Erdkunde of Berlin on the One Hundredth Anniversary of its founding "im Andenken an ihrem unvergesslichen Vorstandsmitglied Alfred Merz, gewidmet vom Institut für Meereskunde."

During recent years the Russians have conducted extensive investigations in the Black Sea. References to some papers on the work have been found but they are very fragmentary. No complete account of the work nor any synopsis or summary of results has been available. To give references to the few publications examined seems inadvisable.

Some notes will be made on the utilization of temperature and salinity in determining oceanic circulation. The methods of modern dynamical oceanography rest primarily on the researches of V. Bjerknes and V. W. Ekman, but the developments and elaborations by Helland-Hansen, Sandström, Hesselberg and Sverdrup, and others, have been invaluable in building up not only the principles but also the technique of practically applying the principles. Two summaries of modern methods will be mentioned. They are Albert Defant's "Dynamische Ozeanographie"<sup>4</sup> and G. F. McEwen's "A summary of basic principles underlying modern methods of dynamical oceanography."<sup>5</sup>

Concurrently with increase in knowledge of the physics of the sea and of the methods of utilizing the physical facts derived from the sea in solving problems of circulation, better plans for work at sea have been formulated and there has been improve-

<sup>1</sup> See article by G. Wüst, this volume, p. 12.

<sup>2</sup> Conseil internat. Explor. Mer, Jour., vol. 5, pp. 7-21, 1930. The bibliography contains references to pertinent literature.

<sup>3</sup> Gesellsch. Erdkunde Berlin, Jubiläums-Sonderband, 1928, pp. 459-505, 1928.

<sup>4</sup> Einführung in die Geophysik III, Berlin, verlag von Julius Springer, 1929, pp. 222.

<sup>5</sup> Physics of the Earth, vol. 5, U. S. National Res. Council Bull. 85, pp. 310-357, 1932. There are three pages of bibliography.

ment in oceanographic instruments. It is now generally recognized that oceanographic stations should be closely spaced in nets, so as to make it possible to construct sections in almost any direction, and the observations and collections should extend to the bottom. The instruments used in recording temperatures and determining the depths at which observations and collections are made must be of a high order of precision. The bottles for collecting water samples must be efficient—they *must not leak*. The titrations for chlorine must be made with the greatest attainable accuracy, for on them depends the calculations of salinity and density. The object is to make accurate physical measurements for use by mathematical methods, or by graphical methods which require as great precision as the mathematical treatment.

Nearly all modern oceanographic work, both at sea and in the laboratory, whether on shipboard or on land, meets the requirements of accuracy, but many older observations and determinations, some of rather recent date, are faulty. Since Professor Wüst in the article by him translated for this volume has adequately discussed methods of testing the accuracy of observations and determinations, nothing more will be said on the subject in this place.

For this volume the compilation for the Norwegian, North Polar, and adjacent seas was made by Dr. H. U. Sverdrup and Prof. B. Helland-Hansen; that for the Atlantic Ocean by Professor Wüst; and most of that for the Gulf of Mexico and Caribbean Sea by Dr. A. E. Parr and Mr. C. Iselin. For other ocean areas, except to use data already published by Professor Defant, the data have been assembled by the compiler of this volume. As has been stated, most modern records, such as those on the ARMAUER HANSEN, the DANA, the DISCOVERY Expeditions, the MABAHISS, and a number of other vessels are acceptable. For the Pacific Ocean a card catalogue of stations at which hydrographic observations were made, similar to the catalogue initiated by Merz, was started. Many hundreds of cards were prepared and T-S curves of the usual kind were drawn for each of the stations represented by a card. Two facts quickly became obvious. The first was that most of the older records were too inaccurate to be serviceable in the study of the dynamics of the water masses, and, except those stations plotted on Defant's charts, most of them were discarded. The second fact was that to prepare cards for all stations in the Pacific and to draw T-S curves would require

more time than was available for the preparation of this report. The cards and T-S curves that had been prepared were used as checks, in so far as possible. Those who may use this report will have to be guided by the names of the vessels and the dates of the observations in passing on the trustworthiness of the records.

There are a few warnings that can not be too strongly emphasized. The first is that sufficiently accurate subsurface temperatures cannot be determined by the old style reversing thermometers that were not equipped with auxiliary thermometers. The auxiliary thermometers are essential. With proper thermometric equipment the limit of error of the temperature records should not exceed  $\pm 0.01^\circ\text{C}$ ., and it is possible to attain even greater precision, limit of error about  $\pm 0.003^\circ\text{C}$ .. The salinities should be determined by or checked by chlorine titration and the limit of error should not exceed  $\pm 0.01$  ‰. The most recent memoir on the determination of the constants of sea water is that by Willy Bein, Heinz-Günther Hirsekorn, and Lotte Möller, entitled "Konstantenbestimmungen des Meerwassers und Ergebnisse über Wasserkörper."<sup>6</sup> Four methods for determining the density of sea water are given: (1) Optical methods, by the measurement of refraction; (2) electrical conductivity; (3) chlorine titration; (4) direct determination of density. This publication should be studied by all who are working on the physics of seawater and dynamical oceanography.

In addition to the warnings already given, there is another. It is the necessity of precision in the determination of the depths at which temperature records and collections of samples are made. Depths intermediate between the surface and the bottom should be determined by means of unprotected reversing thermometers. Because of errors in the determination of depths, probably due to too great wire-angle, some temperature records that seem to be accurate enough have had to be discarded.

When the expense of conducting oceanographic operation at sea is so great, no pains should be spared to procure and use properly the best obtainable instruments. Unless the precautions above indicated are heeded, observations made at great cost may possess little, even no value.

Surface temperatures and temperatures at shallow depths are considered not at all or only casually in this compilation. Whenever a station is occupied

<sup>6</sup> Institut für Meereskunde, Veröffent. N. F., Heft 28, pp. III, 240, 14 pls., 1935.

for vertical sections of temperature and salinity, it is customary to make a record of the surface temperatures and to collect a sample of the water at the surface for the determination of the salinity. Schott has published compilations for both the Atlantic and Pacific Oceans, and there are numerous other publications. The Australian Meteorological Service is preparing and distributing quarterly charts of surface temperatures for the area bounded by longitude 90° and 165°E. and by latitude 0° to 45°S.; the Royal Netherlands Meteorological Service has recently issued a large two volume folio atlas of charts for the China Sea; the Marine Observatory at Kobe is publishing records of sea-surface temperatures made by Japanese vessels; the Hydrographic Office of the United States Navy has published monthly charts of sea-surface temperature by one-degree quadrangles for the north Pacific and it has other compilations in progress. Other organizations, such as the Marine Division of the Royal British Meteorological Service, are also studying sea-surface temperatures. Sea-surface temperatures, as well as surface currents, are significant for the study of various meteorological problems. A note has already been made on the possible value of such information in attempts at long-range weather forecasting. The value for navigational purposes is obvious.

It is clear from what has been said that the emphasis in the present section of this volume is mostly on the temperature and salinity of the water at depths of 1000 meters and more. Not so much attention is given to shallow depths, but the subject should not be passed over without some consideration. Defant in his paper already referred to, "Systematische Erforschung des Weltmeeres," proposed to divide ocean waters between the Polar fronts into three layers (a) a surface layer of agitation and nearly uniform temperature; (b) a lower layer in which the temperature decreases rapidly, the layer of the thermocline; and (c) a still lower layer in which the temperature range is slight, only a few degrees Centigrade. The upper two layers (a and b) are designated the troposphere; while the lower layer (c) is called the stratosphere. The papers by Wüst already cited contain discussions of the tropospheric and stratospheric circulations in the three oceans. Defant in his memoir, "Die Troposphäre"<sup>7</sup> gives an elaborate account of the

various features of the Atlantic troposphere and its circulation. The sources of the data are also given. Defant follows Wüst in considering the minimum oxygen layer as the base of the troposphere. Further consideration of the southwestern north Atlantic is contained in the two papers by Günter Dietrich cited below.<sup>8</sup> The interpretations of the tropospheric and part of the stratospheric circulation of the oceans advocated by Wüst, Defant, and Dietrich are not accepted by all oceanographers, as has been expressed by Iselin.<sup>9</sup>

Iselin calls attention to two views regarding the depth of the lower boundary of the major ocean currents. According to the older view the velocity gradually decreases with depth but there is some flow parallel to the surface movements down to at least 2,000 meters. According to the newer view the layer of water with the minimum oxygen content is nearly motionless and marks the lower limit of surface currents. The axis of the minimum oxygen layer varies from depths of 300 to 400 meters near the equator to 800 meters in higher latitudes. The results of calculations of the volume and the velocity of ocean currents are conditioned by which of the above theories the particular investigator favors. Very divergent results are obtained according to the interpretation adopted. The relative merits of the proposed interpretations will not be discussed in the present volume. Only the differences of opinion will be pointed out and it will be said that additional careful, critical investigation is needed.

The data on serial sections of temperature and salinity besides being of value in studies of problems of oceanographic circulation are indispensable for computing oceanic depths from the time interval in deep-sea sounding by means of echo methods.

Since the positions of the stations that have been occupied for serial sections of temperature and salinity are shown on the charts of the different oceans, it does not seem necessary to discuss in detail in the text of this volume those areas on which information is deficient. But it will be remarked, that there are still enormous areas in the Pacific Ocean on which there are no data that can be

<sup>8</sup> Dietrich, Günter, Die Lage der Meeresoberfläche im Druckfeld von Ozean und Atmosphäre, mit besonderer Berücksichtigung des westlichen nord atlantischen Ozeans und des Golfes von Mexiko: Inst. Meereskunde Berlin, Veröffentl. N. F., Geogr.-naturwiss. Reihe, Heft 33, pp. 1-52, Jan. 1937.

Dietrich, Günter, Ueber Bewegung und Herkunft des Golfstromwassers: Ibid., pp. 53-91.

<sup>9</sup> Iselin, Columbus, How deep do ocean currents flow: Abstract of paper presented before National Academy of Sciences, April 26, 1937, Science, vol. 85, p. 439, May 7, 1937.

<sup>7</sup> Defant, A., Schichtung und Zirkulation des Atlantischen Ozeans, dritte Lieferung, Die Troposphäre: Wissenschaft. Ergeb. METEOR. Exped. 1925-1927, vol. 6, pt. 1, pp. 289-411, text-figs. 26-76, pls. 36-54a, 1936.

used for the study of the physical and chemical properties and the movements of the water masses—for example, west of the Galapagos Islands, between the equator and  $10^{\circ}$  of north latitude, to  $140^{\circ}$  west longitude, there is no information except at one station on the equator which was occupied for subsurface temperature. There are no data on the area between  $10^{\circ}$  and  $20^{\circ}$  north latitude and  $100^{\circ}$  and  $130^{\circ}$  west longitude. In the south Pacific there are large areas within which there are no available observations. In the west Pacific west of  $170^{\circ}$  west longitude over to the area of operation of the Japanese there are very few observations.

In the Indian Ocean, between the areas recently worked by the *MABAHISS* and the *DANA* in its northern part, and the areas investigated by *DISCOVERY I* and *DISCOVERY II* and *NORWEGIA* around Antarctica, and between lines from Antarctica to the Cape of Good Hope and from Antarctica to southern Australia, there are very few observations. There are many areas 10 degrees of latitude and 10 degrees of longitude on a side for which there is not a single observation.

Until more oceanographic observations have been made in these areas it will not be possible to solve

numerous important oceanographic problems. For example, for the strip, between  $10^{\circ}\text{S}$  and  $20^{\circ}\text{N}$  latitude, across the Pacific Ocean that includes the North Equatorial Current, the Equatorial Counter Current, and the South Equatorial Current there are very few observations. The *CARNEGIE* in its cruises in the Pacific crossed this belt along three lines and a few observations were made by the *DANA*. Otherwise, except records of temperature and one line of serial sections of temperature and salinity, reliable data are confined to the east and west ends of the belt.

To make more extended comments seems unnecessary.

Professors Sverdrup, Helland-Hansen, and Wüst have put on the charts prepared by them the numbers for the different stations, as well as abbreviations. It would have been preferable to have done this for the other stations instead of merely putting down the abbreviations for the names of the vessels from which the observations and collections were made, but with the references to sources of data additional information on the stations can be procured by those who desire it.

# ATLANTIC OCEAN AND CONNECTING SEAS

## OCEANOGRAPHIC DATA, VERTICAL SECTIONS OF TEMPERATURE AND SALINITY FOR THE NORWEGIAN SEA, THE POLAR SEA, AND ADJACENT AREAS

BY PROF. HARALD U. SVERDRUP

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AND

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PLATES 1, 2, 3

Following the plan agreed upon during conferences in Bergen I have completed the compilation of the oceanographic data from the Norwegian Sea, the Polar Sea, and adjacent areas.

I had special charts of the Norwegian Sea made and on these the available observations of temperature and salinity at the depths 500, 1000, and 2000 meters have been entered. I included the 500 meter level in order to give a more comprehensive view of the greater amount of material which is available from the upper layers. In the charts the 1000 meter isobath has been shown. It will be noted that some stations with observations below 1000 meters fall inside the line. The reason is that the depth curve has been taken from Helland-Hansen and Nansen's bathymetric chart of the Norwegian Sea of 1909 and has not been corrected according to results of later soundings. The chart, however, can not be much in error.

I include here lists giving:

1. Abbreviations used in the charts.
2. List of publications containing observations from the Norwegian Sea.
3. List of publications containing observations from the sea east of Spitsbergen, Murman Sea, Barentz Sea, etc.
4. List of publications containing observations from the Kara Sea, the Siberian Sea, the Polar Sea, etc.
5. List of publications containing observations from the Baltic.

No special list of publications containing observations from the North Sea has been prepared, since practically all data are contained in the Bulletins of the Conseil International.

I beg to note that a great number of observations

in the Faeroe-Scotland channel have not been entered in the charts, because they would become overfilled.

I hope that the lists are complete, but our library and the other libraries to which we have access may not contain all existing publications.

Since the paper prepared by Professor Sverdrup could not be promptly published after it was submitted, additional oceanographic observations needed to be incorporated. This supplement was kindly undertaken by Prof. B. Helland-Hansen, the Director of the Geophysical Institute at Bergen, who makes the following comments:

The published observations are to be found in the Bulletins Hydrographiques. The stations are marked and distinguished after the same principles as have been used by Sverdrup. Data from the Bulletins are indicated thus: Bull. 1932 C17, 1933 C18, 1934 C19, and 1935 C20. For 1933 I have also entered some stations marked C18<sup>II</sup>. The observations are to be found in an appendix for that year, accompanying the Bulletin for 1934. All of them are made by the Norwegian sealer HEIMLAND I. The areas neglected by Sverdrup and mentioned in his text, have been neglected here too.

Beside the stations from which observations have been published in detail, I have also marked on the charts all the stations occupied by the ARMAUER HANSEN in the southern part of the Norwegian Sea 1935 and 1936. These stations are not distinguished by any letters; the numbers for each year are indicated in such a way that the number of every station can be found out. It will be some time before the observations can be printed. They will be published in connection with all our meteorological observations and the results of dynamic calculations. I think that it may be of interest to see the grouping of these stations. It may be added that our observations in The Norwegian Sea from 1935 and 1936 only rarely embrace 500 meters. We had in 1935 observations at 400 and 600 meters wherever the depth to the bottom was large enough. Most of these stations are indicated in the chart for 1,000 meters. In 1936 we also had

stations between those indicated in the chart for 1,000 meters, but there the observations were made only down to 400 meters. Thus, for 400 meters, we had in 1936 many more stations than shown in the charts.

*Abbreviations used on the charts*

- Temperature.
- Salinity.
- ⊙ Temperature and salinity.
- 2 The publication gives 2 observations at one position.
- A Nansen, F.: Northern waters. Videnskabs-Selskabets Skrifter 106. I. Mat.-Naturv. Klasse, No. 3. (Christiania 1906.)
- AH ARMAUER HANSEN.
- B BLÅFJELD.
- B1 Bulletin (Trimestriel) des Résultats acquis pendant les croisières périodiques. Conseil International. (Copenhagen 1903-08.)
- Année 1902-03.
- B2 1903-04.
- B3 1904-05.
- B4 1905-06.
- B5 1906-07.
- B6 1907-08.
- BR Braarud, Trygve, and Ruud, Johan T.: The ØST Expedition to the Denmark Strait 1929. I. Hydrography. Hvalrådets Skrifter Nr. 4. (Oslo 1932.)
- C1 Bulletin Hydrographique. Conseil International. (Copenhagen 1910-.)
- Année 1908-09.
- C2 1909-10.
- C3 1910-11.
- C4 1911-12.
- C5 1912-13.
- C6 1913-14.
- C7 1920-21-22-23.
- C8 1924.
- C9 1923-24. Append. I and II.
- C10 1925.
- C11 1926.
- C12 1927.
- C13 1928.
- C14 1929.
- C15 1930.
- C16 1931.
- Da Danish observations.
- Ec Scottish observations.
- F Åkerblom, Filip: Recherches océanographiques. Uppsala Univers. Årskrift 1903. Mat. and naturv. II. (Uppsala 1904.)
- Fa FARM and BLOMSTERSAEL.
- G Great Britain observations.
- H Helland-Hansen, Bjørn: Physical Oceanography and Meteorology. Part II; repr. from Rep. of the Scientific Results of the MICHAEL SARS North Atlant. Deep Sea Exped. 1910. Vol. I. (Bergen 1930.)
- Ha Hamberg, Axel: Hydrographische Arbeiten der von A. G. Nathorst geleiteten schwedischen Polarexpedition 1898. Kungl. Svenska Vetenskaps-Akademiens Handlingar, vol. XLI, No. 1. (Stockholm 1906.)
- Hj JOHAN HJORT.
- HO Duc d'Orléans: Croisière Océanographique accomplie à bord de la BELGICA dans la Mer du Grønland 1905. Oceanographie et Biologie. Journal des stations. (Bruxelles 1909.)
- I Helland-Hansen, Bjørn and Nansen, Fridtjof: The sea west of Spitsbergen. Skrifter utgitt av Videnskapsselskapet i Kristiania Mat.-Naturv. Klasse, 2 bind. (Kristiania 1913.)
- IK Knudsen, Martin: Hydrography. The Danish Ingolf-Expedition, Vol. I, Part I, No. 2. (Copenhagen 1899.)
- M-I-4 Nielsen, J. N.: Hydrography of the Waters by the Faroe Islands and Iceland during the Cruises of the Danish Research Steamer THOR in the summer 1903. Medd. fra Komm. for Havundersøgelser Serie: Hydrografi, Bind I, No. 4. (København 1904.)
- M-17 Nielsen, J. N.: Contribution to the Hydrography of the Waters North of Iceland. Medd. fra Komm. for Havunders. Serie: Hydrogr. Bind I, No. 7. (København 1905.)
- M-19 Nielsen, J. N.: Contribution to the Hydrography of the Northeastern Part of the Atlantic Ocean. Medd. fra Komm. for Havunders. Serie: Hydrografi, Bind I, No. 9. (København 1907.)
- MS Helland-Hansen, B. and Nansen, F.: The Norwegian Sea. Rep. on Norwegian Fishery and Marine Investigations, Vol. II, No. 2. (Bergen 1909.)
- MS-01 Ibid.
- MS-02 Ibid.
- N Nansen, Fridtjof: Spitsbergen Waters. Videnskabs-Selskabets Skrifter 1915. I. Mat.-Naturv. Klasse, No. 2. (Christiania 1915.)
- pg Page.
- RA Martens, Erik: Hydrographical Investigations during the MICHAEL SARS Expedition 1924. Rapports et Proces-Verbaux des Reunion, Vol. LVI. (Copenhagen 1929.)
- S7 Sjöstrand, Johannes: De hydrografiska förhållandena i Norra Ishavet mellan norska kusten och Spetsbergen etc. år 1920. Ur Svenska Hydrografisk-Biologiska Kommissionens Skrifter. VII. (Göteborg 1922.)
- Sc Scottish observations.
- T TOVIK.
- W Sverdrup, H. U.: The Wilkins-Ellsworth Arctic Expedition, Scientif. Results, Part I; II Oceanography. Papers in Physical Oceanography and Meteorology, Vol. II, No. 1. Publ. by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution.

SOURCES OF DATA, THE NORWEGIAN SEA  
(Iceland, East-Greenland, Spitsbergen, and Norwegian Waters)

PUBLICATIONS	ABBREVIATIONS	OBSERVATIONS AT DEPTH OF
<b>Bulletin (Trimestriel) des Résultats acquis pendant les croisières périodiques.</b>		
Conseil International. Copenhagen 1903-08:		
Année 1902-03. (Da(nish), N(orwegian) and Sc(ottish) observations)	B	2000, 1000, 500 meters
Année 1903-04. (Da., N., Sc. observations)	B2	2000, 1000, 500 m.
Année 1904-05. (Da., Sc. observations)	B3	1000, 500 m.
Année 1905-06. (Da., Sc. observations)	B4	1000, 500 m.
Année 1906-07. (Sc. observations)	B5	1000, 500 m.
Année 1907-08. (Sc. observations)	B6	1000, 500 m.
<b>Bulletin Hydrographique. Conseil International. Copenhagen 1910- :</b>		
Année 1908-09. (Sc. observations)	C1	1000, 500 m.
Année 1909-10. (Da., Sc. observations)	C2	1000, 500 m.
Année 1910-11. (N., Sc. observations)	C3	1000, 500 m.
Année 1911-12. (Sc. observations)	C4	1000, 500 m.
Année 1912-13. (N. observations)	C5	500 m.
Année 1913-14. (Sc. observations)	C6	1000, 500 m.
Année 1920-21-22-23. (Sc. observations)	C7	1000, 500 m.
Année 1924. (Da., N., Sc. observations)	C8	1000, 500 m.
Année 1923-24 Append. I and II. (N. observations with JOHAN HJORTH, BLÅFJELD, ARMAUER-HANSEN, TOVIK, FARM, and BLOMSTERSAEL)	C9	1000, 500 m.
Année 1925. (Da., N., Sc. observations)	C10	1000, 500 m.
Année 1926. (N. observations)	C11	500 m.
Année 1927. (N., Sc. observations)	C12	500, 1000 m.
Année 1928. (N. observations)	C13	1000, 500 m.
Année 1929. (N., Sc., observations)	C14	1000, 500 m.
Année 1930. (N. observations) D. at East-Greenland below 500 m.	C15	1000, 500 m.
Année 1931. (N. observations)	C16	500 m.
NB: Ca. 80 observations at 1000 m. in the area between 60°-62° N. Lat. and 0°-10° W. Long. are not inserted on the chart. The observations are published in the following "Bulletins": B3, B5, B6, C1, C2, C3, C4, C6, C7, C8, C10, C12, C14		
A large number of observations in the area between 60°-64° N. Lat. and 0°-10° W. Long. are not inserted on the 500 m. Chart		
Report (Northern Area) on fishery and hydrographical investigations in the North Sea. (London 1904- .) In these publications are given supplementary statements to the Scottish observations printed in the "Bulletin Hydrographique"	Below 500 m.	
BRAARUD, TRYGVE, and KLEM, ALF: Hydrographical and Chemical Investigations in the Coastal Waters off Møre and in the Romsdalsfjord. Hvalrådets Skrifter Nr. 1. (Oslo 1931)	BR	500, 1000 m.
DUC D'ORLEANS: Croisière Océanographique accomplie à bord de la Belgica dans la Mer du Grønland 1905. Océanographie et Biologie. Journal des stations. (Bruxelles 1909)	HO	2000, 1000, 500 m.
HAMBERG, AXEL. Hydrographische Arbeiten der von A. G. Nathorst geleiteten schwedischen Polar-expedition 1898. Kungl. Svenska Vetenskaps-Akademiens Handlingar, vol. XLI, No. 1. (Stockholm 1906)	H	1000, 500 m.
HELLAND-HANSEN, B. and NANSEN, F.: The Norwegian Sea, Norwegian Researches 1900-04 with MICHAEL SARS. Report on Norwegian Fishery and Marine Investigations, Vol. II, No. 2. (Bergen 1909)	MS MS-01 MS-02	2000, 1000, 500 m.
KNUDSEN, MARTIN: Hydrography. In The Danish Ingolf-Expedition. Vol. I, Part I, No. 2. (Copenhagen 1899)	IK	2000, 1000, 500 m.
The temperatures are stated only to tenths of a Centigrade.		
MAKAROFF, S.: Yermak wo ljedakh (In the ice) (St. Petersburg 1901)		
MARTENS, ERIK: Hydrographical Investigations during the MICHAEL SARS Expedition 1924	RA	1000, 500 m.
and		
MARTENS, ERIK: Hydrographical Investigations in the Norwegian Sea off Møre 1925-28. In Rapports et Proces-Verbaux des Reunion, Vol. LVI		500 m.

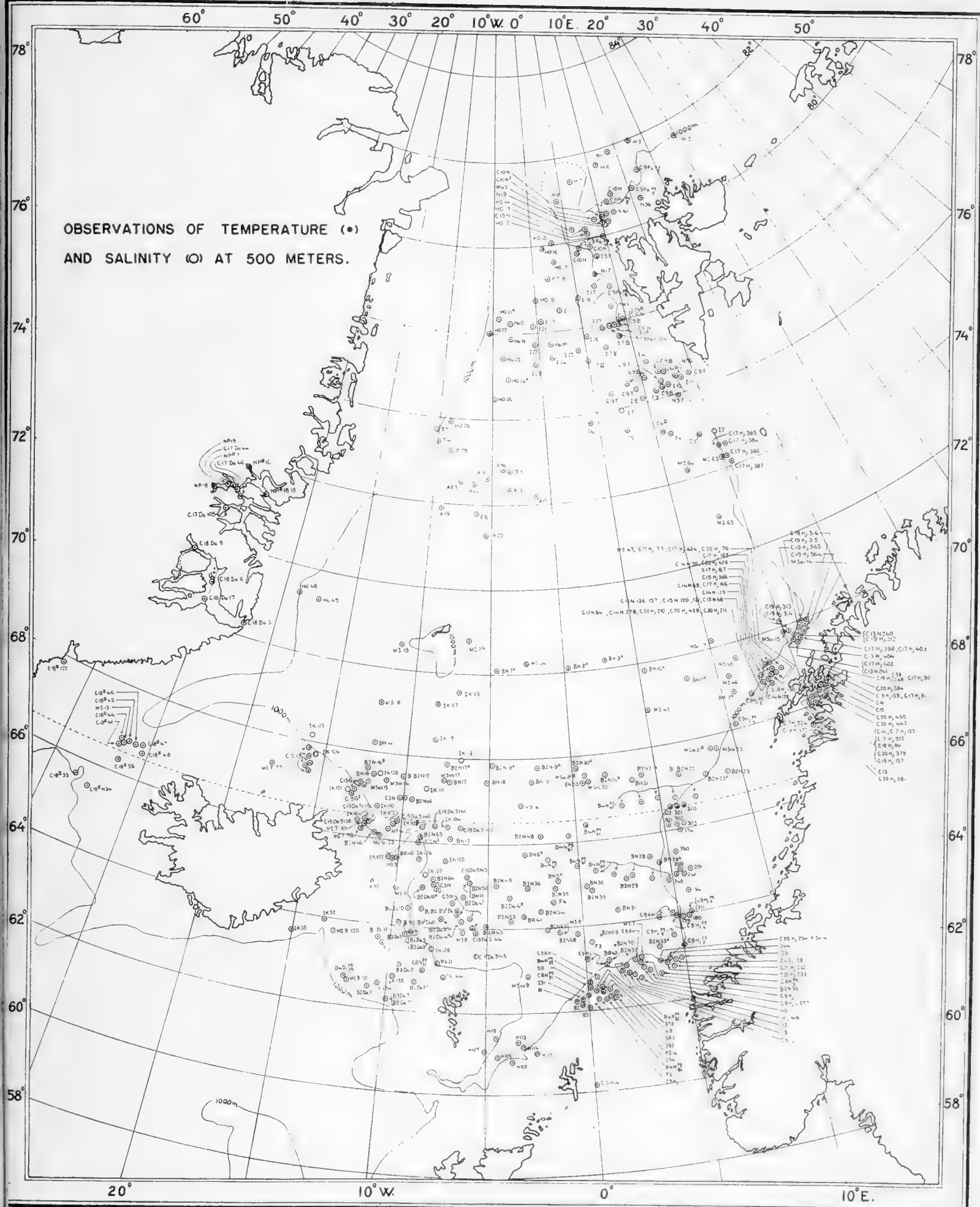
PUBLICATIONS	ABBREVIATIONS	OBSERVATIONS AT DEPTH OF
NANSEN, F.: Northern Waters. (Capt. Roald Amundsen's oceanogr. observations in the Arctic Seas (1901). Videnskabs-Selskabets Skrifter 1906. I. Mat.-Naturvidensk. Klasse, No. 3. (Christiania 1906)	A	2000, 1000, 500 m.
NANSEN, FRIDTJOF: Spitsbergen Waters. Oceanogr. observations during the cruise of the <i>VESLEMØY</i> to Spitsbergen in 1912. Vidensk.-Selskabets Skrifter 1915. I. Mat.-Naturvidenskapelig Klasse, No. 2. (Christiania 1915)	N	1000, 500 m.
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NIELSEN, J. N.: Contribution to the Hydrography of the Waters North of Iceland. Medd. fra Komm. for Havundersøgelser. Serie: Hydrografi, Bind I. No. 7. (København 1905)	M-17	500 m.
NIELSEN, J. N.: Hydrography of the Waters by the Faroe Islands and Iceland during the cruises of the Danish research steamer <i>THOR</i> in the summer 1903. Medd. fra Komm. for Havundersøgelser. Serie: Hydrografi, Bind I. No. 4. (København 1904)	M-14	1000, 500 m.
SJØSTRAND, JOHANNES. De hydrografiska förhållandena i Norra Ishavet mellan norska kusten och Spetsbergen etc. år 1920. Ur Svenska Hydrografisk-Biologiska Kommissionens Skrifter. VII. (Göteborg 1922)	S7	500 m.
SVERDRUP, H. U.: The Wilkins-Ellsworth Arctic Expedition, Scientific Results, Part I; II Oceanography. Papers in Physical Oceanography and Meteorology, Vol. II, No. 1. Published by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution	W	2000, 1000, 500 m.
TROLLE, ALF: Hydrographical Observations from the Denmark Expedition. Danmark-Ekspeditionen Til Grønlands Nordøstkyst 1906-08. Bind I. Nr. 2. Reprinted from "Meddelelser om Grønland." Bind XLI. (København 1913)	T	2000, 1000, 500 m.
ÅKERBLUM, FILIP: Recherches oceanographiques. Expedition de M. A. G. Nathorst en 1899. Uppsala univers. Årsskrift 1903. Mat. & naturv. II. (Uppsala 1904)	F	2000, 1000, 500 m.

The following publication is not included in the list, the temperatures being stated only in tenths of a centigrade, and the salinities being useless:

RYDER, C.: Den østgrønlandske Expedition 1891-1892. Part I. V. Hydrography. Meddelelser om Grønland, Bind XVII. (Kjøbenhavn 1895)	1000, 500 m.
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#### SOURCES OF DATA, THE SEA EAST OF SPITSBERGEN, MURMAN SEA, BARENTS SEA, ET CETERA

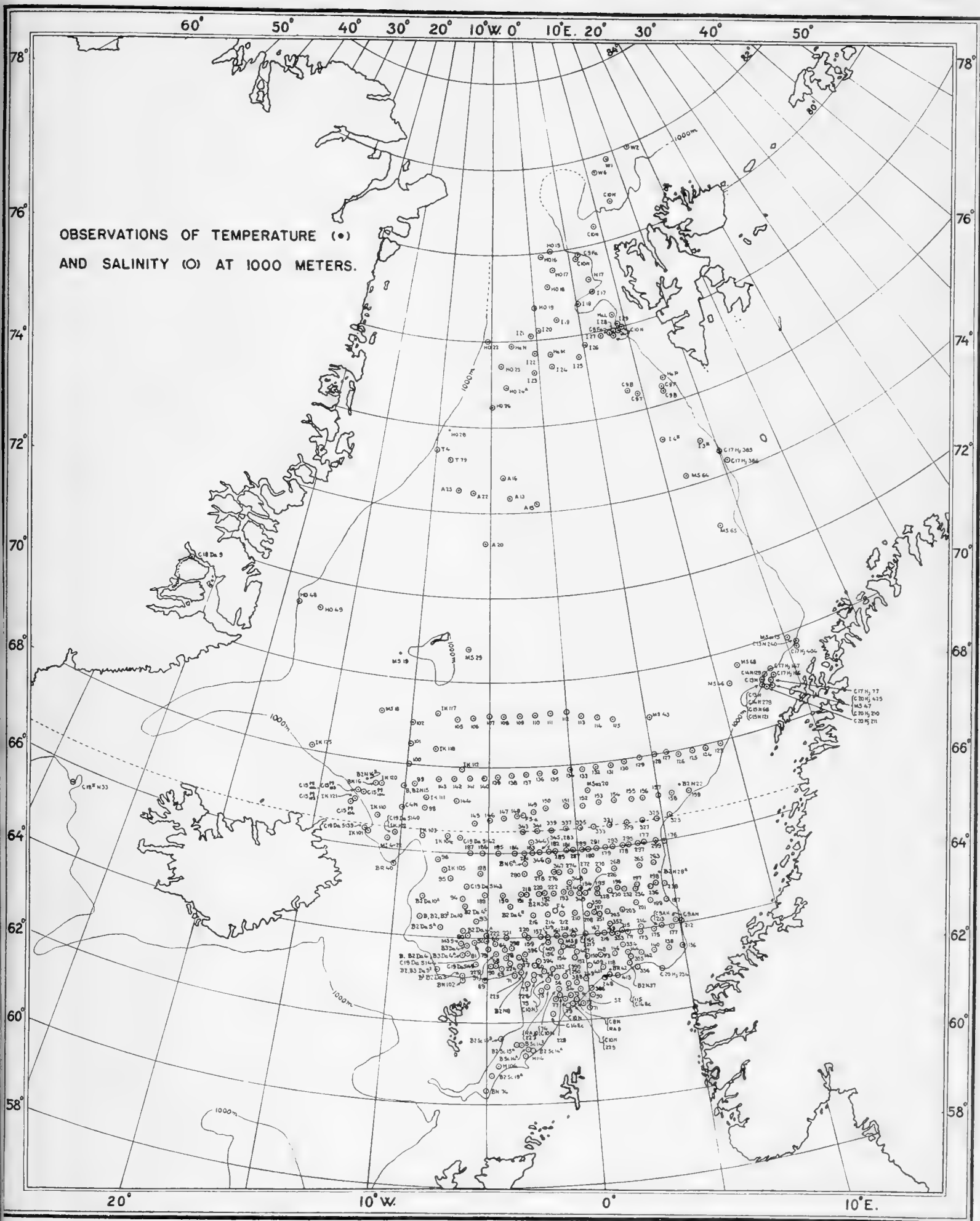
- Bulletin Trimestriel des Résultats acquis pendant les croisières périodiques. Conseil International . . . , Copenhagen. Année 1903-04, 04-05, 05-06, 06-07. (Russian observations.) (Copenhagen 1903-07)
- Bulletin Hydrographique etc. Conseil International . . . , Copenhagen. (Continuation of the above series), 1912-13 (German obs.), 1923-24 Appendices (Norwegian obs.), 1929 (Norwegian obs.). (Copenhagen)
- BREITFUSS, L. L.: Expedition fuer wissenschaftlich-praktische Untersuchungen a. d. Murman-Küste. Bericht über die Tätigkeit pro 1902. (St. Petersburg 1903)
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- SCHULZ, BRUNO: Bericht über die Reise von Wilhelm Brennecke in das Barentsmeer im Frühsommer 1923. Annalen der Hydrographie und Maritimen Meteorologie. LV. Jahrgang, Heft VI. (Berlin 1927)
- SCHULZ, BRUNO and WULFF, ALFRED: Hydrographische und planktologische Ergebnisse der Fahrt des Fischereischutzbootes *ZIETEN* in das Barentsmeer 1926. Berichte



NORWEGIAN SEA, OBSERVATIONS OF TEMPERATURE AND SALINITY AT 500 METERS

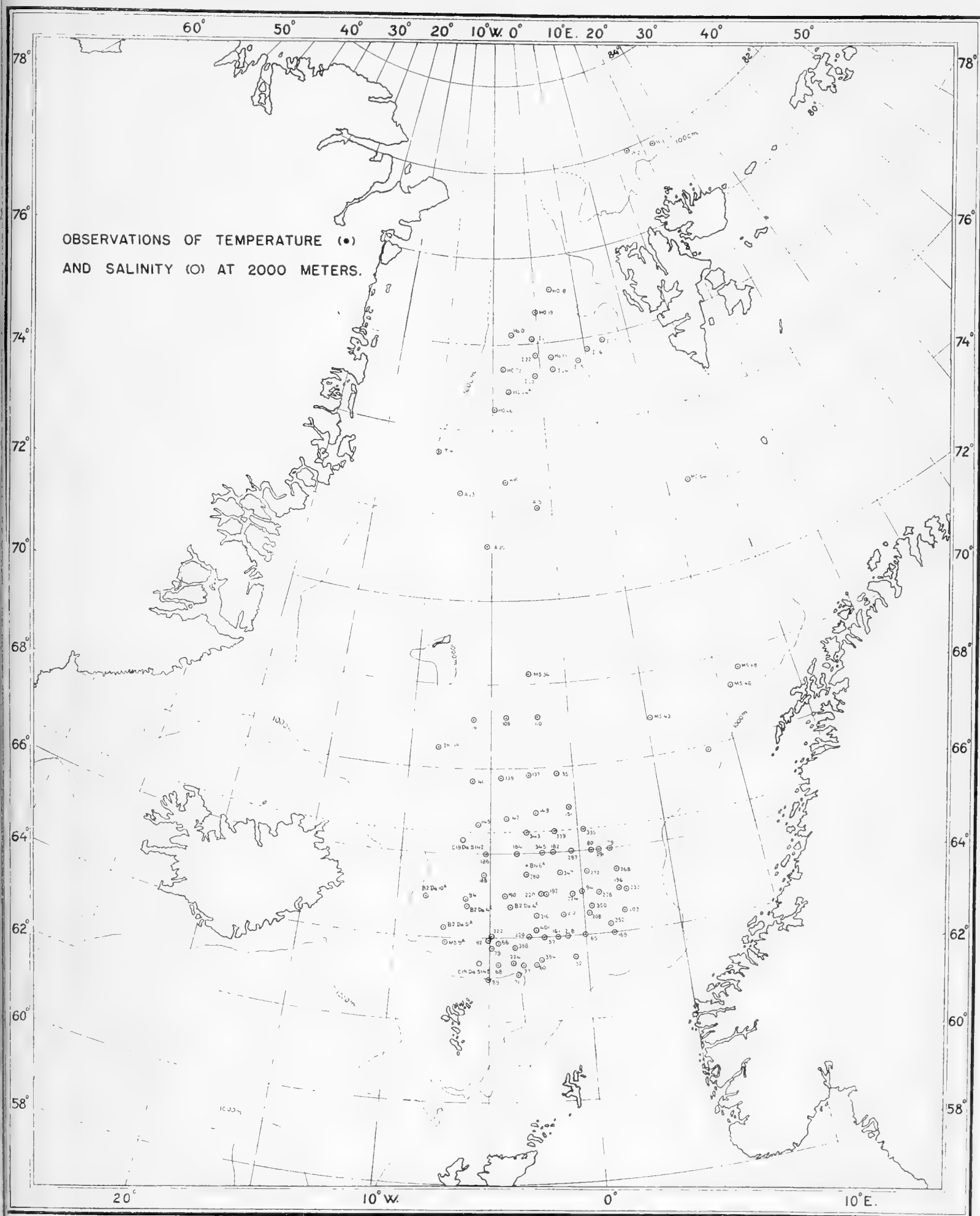
1  
OBSERVATIONS OF TEMPERATURE (°)  
AND SALINITY (‰) AT 800 METERS.





NORWEGIAN SEA, OBSERVATIONS OF TEMPERATURE AND SALINITY AT 1000 METERS





NORWEGIAN SEA, OBSERVATIONS OF TEMPERATURE AND SALINITY AT 2000 METERS



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- WIESE, W.: Scientific Results of the Expedition with MALYGUIN in Barentssea 1928. Transactions of the Institute for Exploration of the North. No. 45. (Moscow 1929)
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- Bulletin Hydrographique. Publié par Conseil International (as continuation of the above series) Copenhagen. Année 1908-09, 1909 etc. 1914. 1920-21-22-23, 1925 etc. 1931. (Danish, Esthonian, Finnish, German, Polish (below 100 meters), Russian and Swedish observations. The Finnish observations later than 1928 incl. may also be found in Havforskningens instituttets Skrift No. 66, 70 etc.) (Copenhagen 1910- )
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and  
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# ATLANTIC OCEAN: HORIZONTAL DISTRIBUTION OF TEMPERATURE, SALINITY AND DENSITY, AT STANDARD DEPTHS<sup>1</sup>

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PLATES 4, 5, 6, 7, 8

## 1. THE SOURCE MATERIAL

In an endeavor to indicate the thermohaline constitution of the oceans in relation to the deep circulation of the water masses, the procedure is not by presenting the data in horizontal and vertical sections but by presenting them as curved surfaces which correspond to the contours of the core layers (Kernschichten) of the stratospheric water bodies. After having first achieved in this way a representation in space of the extension and the mixing of the core water masses, we are prepared for a complete understanding of the horizontal distribution of temperature, salinity, and density at standard depths. Therefore, the construction of the charts, with which the work originally began, is placed at the end of our investigation. The first fundamental preparation for this goes back to A. Merz himself, who, before the expedition, had planned (after 1922) a card catalogue of all hydrographic observations in the three oceans after the dates of the CHALLENGER and GAZELLE expeditions; and for the Atlantic Ocean had completed it for the condition of research up to the beginning of the METEOR expedition. A. Merz<sup>2</sup> has reported in detail in another place on the initiation of the card catalogue, with the preparation of which at that time Doctor H. H. F. Meyer was especially entrusted, and on the point of view, which fixed the method for obtaining values at standard depths. After the end of the expedition the author has carried forward along the lines laid down by Merz the card catalogue for the Atlantic ocean, concerning which more detailed information is given in volume 4 of this work, pp. 7 et seq. Work on the exhaustive collection of all available, uniformly reduced, and prepared observational material took, as a result of the greatly increased number of deep-sea investigations since the METEOR Expedition, so extensive a scope that it could be handled only by a series of coöperators,

of whom special mention should here be made of Doctor G. Böhnecke, Doctor G. Dietrich, Doctor H. H. F. Meyer, and the technical assistants, Misses M. Asché, J. Peter, and J. Zietz. The number of the stations recorded in the card catalogue soon exceeded 10,000. In order not to jeopardize the execution of the Merz plan to represent the constitution of the oceans on charts of oceanographic factors, the author next eliminated all of the shelf regions and adjacent seas except the Caribbean Sea, and devoted attention only to stations exceeding 200 meters in depth in the open Atlantic Ocean. For the open Atlantic Ocean the northern limit was taken as the 65th degree of latitude at the Faroe-Shetland Swell; the limit for the Pacific Ocean was fixed at the 70th meridian of west longitude; and that for the Indian Ocean at the 35th meridian of east longitude.

After the exclusion of the stations for which there are only bottom observations, the results obtained from a study of those that exceed 4,000 meters in depth are presented elsewhere,<sup>3</sup> and after the elimination of all defective series, there remain a total of 3,440 stations with serial measurement of temperature and about 3,100 with simultaneous serial measurements of salinity, executed by about 70 research vessels in the years between 1873 and 1934. For each station large scale vertical curves of temperature and salinity were constructed. When necessary the results of the different expeditions were uniformly reduced to depths in meters, temperatures to degrees centigrade, and, salinities were reported in conformity to Knudsen's hydrographic tables. The values for salinity were, when it appeared necessary, recalculated<sup>4</sup> and tested by the correlation Temperature and Salinity in order to recognize those of defective values, and to calculate the corresponding salinity for the intermediate depths in which there were only temperature data. The vertical curves were, in so far as possible, laid out in geographical order so that in working up the series comparisons could be made between neigh-

<sup>1</sup> Translated by T. Wayland Vaughan from "Schichtung und Zirkulation des Atlantischen Ozeans," Zweite Lieferung "die Stratosphäre." *Wissensch. Ergeb. der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff METEOR 1925-1927*, Vol. 6, 1st Pt., pp. 224-233, 248-251, Beilagen 32-35, 1935.

<sup>2</sup> *Preus. Akad. Wissensch. Phys.-Math. Kl., Ber.*, 1925, vol. 31, p. 58.

<sup>3</sup> This volume, 1st Lieferung.

<sup>4</sup> For example for the CHALLENGER and other series compare: L. Möller: *Zur Kritik und Aufbereitung der Dichte- und Salzgehaltswerte älterer Expeditionen*: Veröff. Inst. f. Meereskde., Reihe A, H. 15, Berlin 1926.

boring stations. While the plotting of the observation points was mostly assigned to technical assistants, the vertical curves were constructed with the greatest possible care by scientific workers. From these curves the temperatures and salinities were taken with estimates to parts per hundred for the standard depths, 200, 400, 600, 800, 1,000, 1,250, 1,500, 1,750, 2,000, 2,500, 3,000, 3,500, 4,000, 4,500, and 5,000 meters. For the older temperature-series Professor Merz, himself, had completed the work. These values together with the abbreviations of the names of the expeditions and of the months of the observations, with the appropriate isobaths, were plotted on surface-true charts on a scale of 1:20 million; for the regions in which there are more numerous observations such as the South Antilles Sea, Newfoundland, and the west European continental slope, special charts on a larger scale were constructed. On the basis of the interpolated values of temperature and salinity, the density values were calculated, which because of the general greater constancy at deep levels made possible another test of the data. In the case of strongly discrepant values it was possible in most instances to decide whether the error lay in the measurement of the temperature or in the determination of the salinity, or whether in the construction of the vertical curves insufficient attention was paid to the correlation of Temperature-Salinity and whether a subsequent equalization of the curves for both factors was necessary. It results from this graphical investigation of the values at standard depths and from the construction of horizontal charts, temperature, salinity, and density, that the curves may not be constructed one independently of the other, but that because of the essential relation between the three factors every bulge in a salinity curve necessarily requires a definite course of the temperature curve, and that the density in depth should show no irregularities. So far as it is attainable by present state of the investigation, the charts of the three factors must be drawn so that one is comparable with the other. Naturally it is not possible to exclude all errors in working up so heterogeneous material. Many bulges and peculiarities in the isotherms, isohalines, and isopycnics apparently are attributable to such sources of error. Among the sources of error, above all other uncertainties that manifest themselves, are those which result from interpolation from observations with relatively wide vertical observational intervals. These uncertainties, especially in the temperature, exceed in

most cases all other sources of error in the measurements; they are uncontrollable in amount if intermediate maxima or minima occur between the points at which measurements are made.

#### A. TEMPERATURE

In this presentation of facts it seems superfluous to give a critical review of the methods of measuring temperatures on the different ships, as has been done for the measurement of bottom temperatures.<sup>5</sup> Also for the present purpose the deep sea thermometers used since 1873 may in general be regarded as sufficiently precise. With the old observations by means of maximum-minimum thermometers, the errors in measurement are mostly due to the subsequent displacement of the index. Systematic deviations even in the depth of the intermediate temperature maxima, where such deviations are to be expected on account of the principle of measurements on which the extreme thermometers are based, are so insignificant that they play no rôle on the horizontal charts. Rather is it necessary to reckon with systematic errors in the measurements with reversing thermometers of the old construction in the years 1885 to 1905. Then in most cases, because of the absence of an auxiliary thermometer, the subsequent expansion of the broken quicksilver mass was not eliminated from the thermometric reading. The temperatures reported by such research vessels as the ALBATROSS, BELGICA, PRINCESS ALICE, and probably also in part those of the GAUSS and POURQUOI PAS, are notably too high, particularly in the great depths of the tropics and the subtropics. With the exception of the METEOR, ATLANTIS, and in part the DEUTCHLAND, which controlled the depth of the reversal by thermometric measurement, we must consider in all serial measurements systematic errors which result from the failure to take into account the wire angle produced by the drifting of the vessel. Because of the strong vertical gradients there, errors due to this cause occur in numerous serial measurements in the upper water layers of the tropics. The strikingly high values which occur in numerous series of the NATIONAL, occasionally also in those of the BERLIN, DISCOVERY, MARGRETHE, and VALDIVIA can be attributed to too great wire angle. Finally there remains to be considered that the measurements were made in different months and years since 1873, and that even the deeper layers

<sup>5</sup> Compare, this volume, 1st Lieferung, pp. 12 et seq.

obviously are not free from marked periodic and secular changes of oceanographic factors which on the horizontal charts are expressed as local deviations. In the higher latitudes, where such secular changes are especially marked, the stations occupied during the summer half of the year are strongly predominant. But, as has been said, in addition to all of these errors and disturbing factors, comes the uncertainty contingent upon interpolation from inadequate vertical observational intervals, and this source of error is many times the most important. All strongly discrepant values were placed in parentheses on the horizontal charts, as soon as they could be attributed with some probability to one of the designated sources of error, and in the construction of the isotherms they were considered either not at all or only with caution. The following table 38 gives a statistical summary of the number of stations with the serial measurement of temperatures, made since 1873 by research vessels and cable ships in the open Atlantic Ocean and available at the Institut für Meereskunde at the beginning of 1934.<sup>6</sup> Four layers, 200–1000 m., 1250–2000 m., 2500–4000 m., and 4000–5000 m., are recognized.

The catalogue of sources is given in the Appendix. The detailed station list and the four charts (supplements XXXII–XXXVI) of the source material make clear the status of the investigation of the open Atlantic Ocean in the four principal layers below 200 meters. Both of the uppermost layers (200–1000, 1250–2000), considering the great extent of the ocean, can be regarded as relatively well investigated (although in the second layer there are less than one half as many serial measurements as in the uppermost layer). But for the deeper layers, greater than 2000 meters, the only relatively well explored regions are the regions investigated by the METEOR, and the South Antilles Sea, the principal region of work of the DISCOVERY Expedition. Of the 743 serial measurements which have yielded the material for the layer between 1250 and 2000 meters the METEOR has supplied 275 series (including the Greenland voyage), and the three ships of the DISCOVERY Expedition have supplied 254 series, which are predominantly in the South Antilles Sea. Then follows the ATLANTIS with 173 series of closely

spaced stations, along lines of special profiles in the northwest Atlantic. As the charts show, the METEOR in its investigation has placed great weight on the investigation of the deepest levels (> 4000 meters), which as a rule have been neglected. Of the 126 series which have supplied values for the horizontal charts (4000 and 5000 meters), the METEOR has contributed 77.

#### B. SALINITY AND DENSITY

In the source material of the salinities we have recognized two fundamentally different groups: (1) Those in which the salinities were determined by physical methods—hydrometer, electrical conductivity (salinity-tester)—which show great uncertainties; and (2) Those which depend upon the chemical method of chlorine titration and which because of the standardization of the method (normal water) are mostly comparable. The series of salinities obtained by the use of hydrometers, which constitute only about three per cent of those for the uppermost layers and a still smaller proportion for the lower layers, notwithstanding modern methods of handling data, are eliminated from the observational material above considered. After the elimination of entirely defective values through the correlation—salinity, such data are utilized only as auxiliary points in regions that are poor in observations. The method of electrical conductivity (salinity-tester), used on the vessels of the Ice Patrol and on the CARNEGIE<sup>7</sup> apparently because of thermal disturbances, is also not sufficiently accurate to recognize the finer differences in salinity in the greater depths. In depths of more than 2000 meters we have therefore placed in parentheses those values obtained in this way. Our salinity charts therefore represent only the distribution of the chlorine content which has been transformed into salinity according to the recognized relation of chlorine to salinity.<sup>8</sup> As already noted, the salinity

<sup>6</sup> For this opportunity I express the thanks of the Institut für Meereskunde to Professor H. Bigelow and Dr. Seiwel for making available manuscript material of the ATLANTIS Expeditions, to Professor Fleming and Professor H. U. Sverdrup for similar material of the CARNEGIE Expedition, and to Professor Helland-Hansen, Professor H. U. Sverdrup, and Doctor H. Mosby for such material from the expedition of the NORVEGIA.

<sup>7</sup> According to a communication in a letter from Professor Sverdrup the limit of error of the electrical method in comparison with that of titration for chlorine reaches about 0.04 ‰ in salinity. On our salinity charts for 1500–4500 meters in depth the CARNEGIE salinity in the open Atlantic Ocean shows on the average around 0.03–0.04 ‰ too low, as does also a comparative consideration of the curves S-f (t) of the CARNEGIE stations with the neighboring stations of other expeditions. (In some places the deviation of the CARNEGIE salinities varies between –0.10 and +0.02 ‰).

<sup>8</sup> Since doubt has recently been expressed as to whether the composition of sea water is sufficiently constant for such a calculation, it has been proposed by Carter, Moberg, Skogsberg, and Thompson, that it would be more precise to abandon this transformation and in its place present charts of chlorine-content. The author cannot agree to this step

values were tested by the construction of the curves showing the relation of salinity to temperature, and defective measurements were recognized in this way and discarded; for the intermediate depths in which only temperature data were available, tiepoints were found for the construction of the salinity vertical curves. Faulty determinations were excluded through this procedure and comparability with temperature made sure. But the uncertainties of interpolation which are due to the many times too great vertical intervals between observations could not be eliminated, and to such sources of error are attributable many irregularities in the isohalines and isopycnics.

Table 39 gives the statistical summary of the number of salinity series which constitute the source material for the horizontal charts of salinity and density in the four layers. In the uppermost layer (200–1000 m.) lie the impressive number of 3047 stations with serial salinities, which are only slightly less than the corresponding number of serial temperatures. The great progress which is shown in the investigation of the salinity of the deeper layers since 1921 is obvious when one calls to mind that W. Brennecke<sup>9</sup> could base his first incomplete attempt to construct charts of the salinity distribution for six deep horizons in 200–1000 m., on only about 100–150 stations, and in some parts of the ocean, because of the absence of observations, had to leave out entirely the drawing of isohalines. Highly noteworthy is the number of serial salinities, 1226, in the next layer (1250–2000 m.). Only 622 stations have supplied material for the layer 2500–4000 m. When one considers the corresponding station chart, he recognizes that up to now, work has been done in a systematic way only by the METEOR, 238 series, in its two regions

because we must take into account conclusions based on the usage for many years of the determined salinity values. It may be recommended, however, that in the future for these determinations the symbol  $S_{Cl}$  be used.

<sup>9</sup> Deutsche Seewarte, Archiv., 1921, p. 165 and plates 13 and 14.

of work in the south and north Atlantic; and by the DISCOVERY, 154 series, in the South Antilles Sea; while the ATLANTIS has worked along profiles the important number of 100 series. For the two lowest horizons (4600 and 5000 m.) the METEOR has contributed 72 series, that is two thirds of the total material. The charts show with clearness the gaps in the thermo-haline investigation of the Atlantic Ocean: North of 15° north and also in the South Polar Sea there is a series of 5°-fields from which there are no serial measurements of temperature and salinity at depths of 2500 meters and more; and as regards its greatest depths, the water of the north Atlantic Ocean north of 20° is almost unexplored.

The results from the working up of all available source material are presented on 45 charts<sup>10</sup> of which 15 are devoted to temperature, salinity, and density.

The foregoing account of the horizontal distribution of temperature, salinity, and density at standard depths in the Atlantic Ocean by Professor Wüst should be supplemented by mention of "A Study of the circulation of the Western North Atlantic," by C. O'D. Iselin.<sup>11</sup> This memoir makes important additions to knowledge of the oceanography of the part of the Atlantic with which it deals. The bibliography accompanying it contains references to several papers published subsequent to the completion of Wüst's manuscript.

Another paper of importance in this connection is one by C. G. Rossby entitled "Dynamics of steady ocean currents in the light of experimental fluids mechanics."<sup>12</sup> This publication deals rather with a possible interpretation than with the presentation of data.

<sup>10</sup> Atlas to this volume.

<sup>11</sup> Papers in Physical Oceanography and Meteorology, published by the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution, vol. 4, No. 4, pp. 101, August, 1936.

<sup>12</sup> Pap. in Phys. Oceanogr., Mass. Inst. Technology and Woods Hole Oceanogr. Institution, vol. 5, no. 1, pp. 43, 1936.

## LISTS OF SOURCES OF DATA

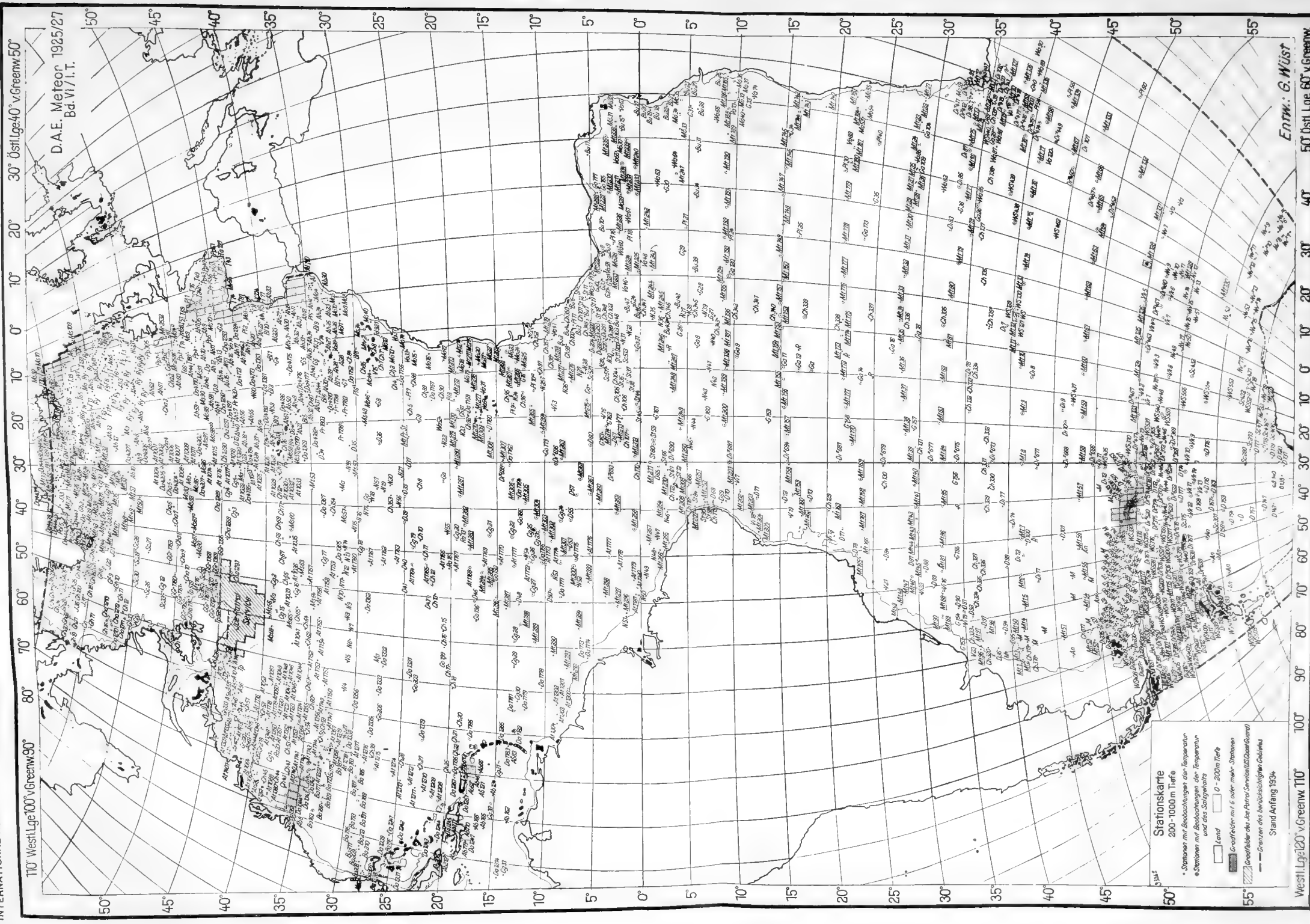
### *Abbreviations of the Ships' Names and Indications of the Sources*

NO.	ABBREVIATION	SHIP	YEAR OF OBSERVATION	SOURCE AND REMARKS
1	A	"Acadia"	1915	P. Bjerkan, Results of the hydrographical observations made by Dr. J. Hjort in the Canadian Atlantic waters. Ottawa 1919.
2	Ab	"Albatross"	1884-85	C. H. Townsend, U. S. Fish Comm. Report for 1900, Washington 1910.
			1919-20	Report U. S. Comm. of Fisheries for 1920. App. III, Washington 1921.

NO.	ABBREVIATION	SHIP	YEAR OF OBSERVATION	SOURCES AND REMARKS
3	Ah	"Armauer Hansen"	1913-14	Bj Helland-Hansen u. F. Nansen, The eastern North Atlantic. Geofysiske Publikasjoner. Vol. IV, Nr. 2. Oslo 1926.
			1922	Ebenda.
4	Al	"Albacora"	1925-26	Rapports et procès-verbaux (Conseil permanent international pour l'exploration de la mer). Bd. 40 u. 44. Kopenhagen 1926 u. 27.
			1927-29	Ebenda. Rapport Atlantique (Cons. perm. intern.). Bd. 55 u. 70. 1927-29. Kopenhagen 1929, 1931.
5	An	"Antarctic"	1901-02	O. Nordenskjöld, Die ozeanographischen Ergebnisse. Wiss. Erg. d. Schwed. Südpolar-Expedition. Bd. I, 2. Stockholm 1917.
6	At	"Atlantis"	1931-32	Bulletin hydrographique 1932 nebst Appendice pour 1931 (Conseil perm. internat.). Kopenhagen 1933.
7	Ba	"Bache"	1914	Report U. S. Comm. of Fisheries for 1915. App. V, Washington 1917.
8	Be	"Belgica"	1898	Rés. du voyage du S. Y. "Belgica" 1897/99. Océanographie. Antwerpen 1908.
9	Bl	"Berlin"	1924	Handschrift der Beobachtungen des Kreuzers "Berlin" im Institut f. Meereskunde Berlin.
10	Bu	"Buccaneer"	1886	J. Y. Buchanan, The exploration of the Gulf of Guinea. The Scottish Geogr. Magazine 1888 (abgedruckt in: J. Y. Buchanan, Scientific papers, Cambridge 1913).
11	Cdo	"Cinco de Outubro"	1923	Rapports et procès verbaux. (Cons. perm. internat.) Bd. 35. Kopenhagen 1925.
12	Cg	"Carnegie"	1928	Handschriftliches Material der Carnegie Institution (Prof. Fleming).
13	Ch	"Challenger"	1873-76	Report on the scientific results of the voyage of H. M. S. Challenger, Physics and chemistry. Vol. I, London 1884.
14	Cha	"Challenger"	1932	Bulletin hydrographique 1932. (Cons. perm. internat.) Kopenhagen 1933.
15	Cn	"Chance"	1926	C. Iselin, A report on the coastal waters of Labrador. Proceedings Americ. Ac. of Arts and Sciences. Vol. 66, Nr. 1. 1930.
16	D	"Deutschland"	1911-12	W. Brennecke, Die ozeanographischen Arbeiten der Deutschen Antarktischen Expedition 1911-12. Aus dem Archiv d. Dt. Seewarte, Hamburg 1921.
17	Da	"Dana"	1921-22	The Danish Expedition 1920-22. Oceanogr. Reports Nr. 1, Introduction by J. Schmidt. Kopenhagen 1929.
			1925	J. P. Jacobsen, Contribution to the hydrography of the North-Atlantic. The Dana Exp. 1921-22. Kopenhagen 1929, S. 54.
			1931	Bulletin hydrographique 1931. (Cons. perm. internat.) Kopenhagen 1932.
			1932	Bulletin hydrographique 1932. (Cons. perm. internat.) Kopenhagen 1933.
18	Di	"Discovery"	1926-27	Discovery Reports Vol. I. Station List 1925-1927. Cambridge 1929.
19	Di*	"Discovery II"	1930-31	Discovery Reports. Vol. IV. Station List 1929-1931. Cambridge 1932.
20	Eo	"Eduardo Dato"	1927-28	Rapports et procès verbaux. Rapport Atlantique (Cons. perm. internat.) Bd. 55. Kopenhagen 1929.
21	Ex	"Explorer"	1929-31	Bulletin hydrographique 1929 u. 1931. (Cons. perm. internat.)
22	F	"Frithjof"	1910	Kopenhagen 1930 u. 1932. F. Nansen, The waters of the north eastern North Atlantic (Internat. Rev. d. ges. Hydrobiol. u. Hydrogr. Hydrogr. Suppl. 2. Serie). Leipzig 1913.

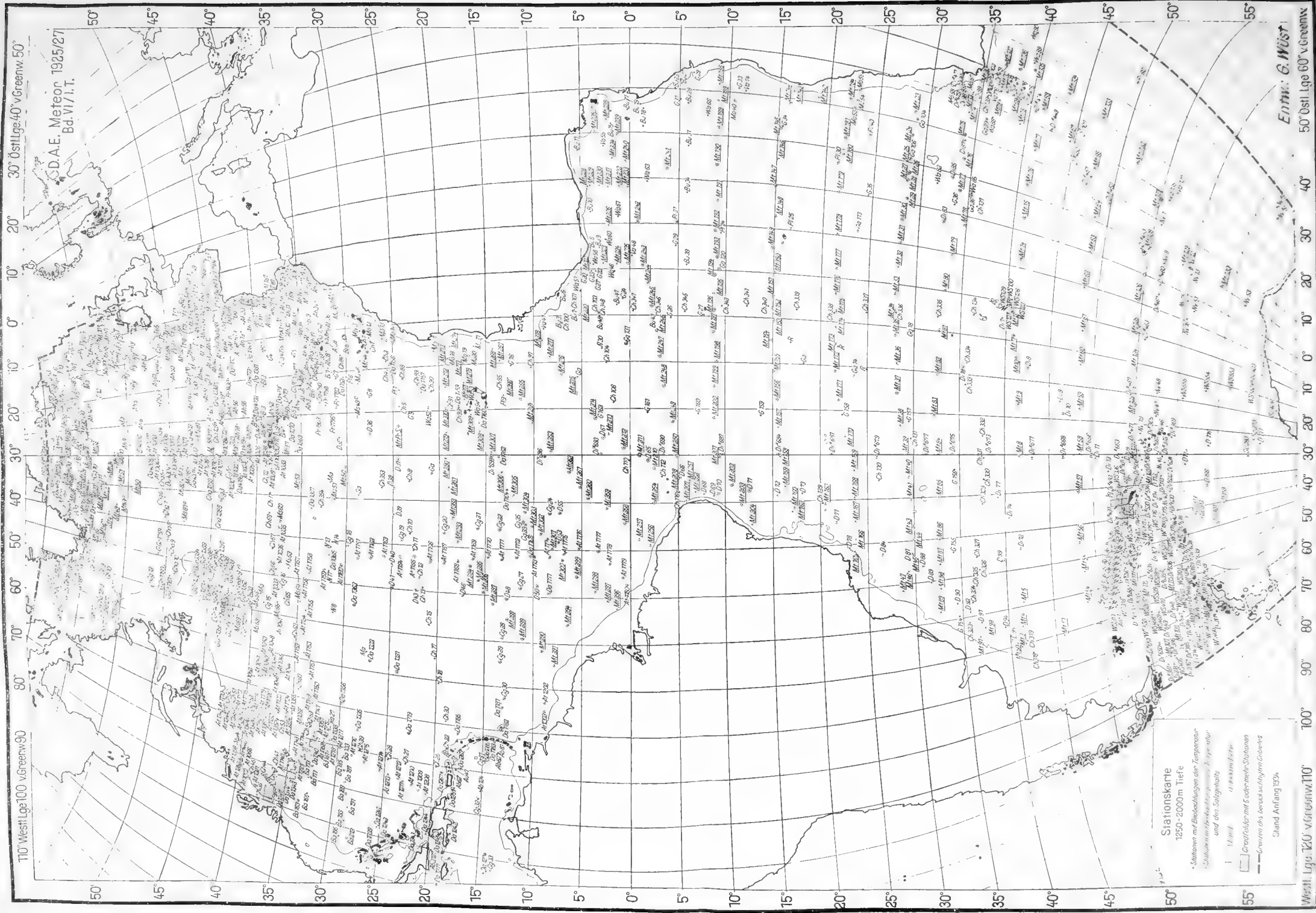
NO.	ABREVI- ATION	SHIP	YEAR OF OBSERVATION	SOURCES AND REMARKS
23	Fk	"Falken"	1912	Bulletin hydrographique 1911-12 (Cons. perm. internat.) Kopenhagen 1913.
24	Fl	"Flinders"	1928	Bulletin hydrographique 1928. (Cons. perm. internat.) Kopenhagen 1929.
25	G	"Gazelle"	1874-76	Die Forschungsreise S. M. S. "Gazelle" 1874/76. Hrsg. v. d. Hydrographischen Amt der Admiralität. Bd. II, Berlin 1888.
26	Ga	"Gauß"	1901-03	E. v. Drygalski, Ozean und Antarktis. Deutsche Südpolar- Expedition. Bd. VIII. Berlin 1925.
27	G Gr	"General Greene"	1931-32	International Ice Observation and Ice Patrol Service 1931/32 (U. S. Treasury Department, Coast Guard Bull. 21). Washington 1932/33.
28	Gh	"Godthaab"	1928	Bulletin hydrographique 1928. (Cons. perm. internat.) Kopenhagen 1929.
29	Go	"Goldfinch"	1902-03	List of oceanic depths for 1903. Hydrogr. Department of the Admiralty. London 1904.
30	Gr	"Grampus"	1914-16	H. B. Bigelow, Doc. 969. Bureau of Fisheries. Washing- ton 1927.
31	Gs	"Goldseeker"	1906-07	Bulletin des resultats Année 1906-07. (Cons. perm. in- ternat.) Kopenhagen 1908.
			1909	Ebenda. Année 1909/10. Kopenhagen 1910.
			1910-11	Ebenda. Année 1910/11. Kopenhagen 1912.
32	Hl	"Helga"	1905-13	Bulletin des résultats. (Teil B) bzw. Bulletin hydro- graphique. Année 1904-05, 1906-07, 1908-09, 1909-10, 1910-12, 1912-13. (Cons. perm. internat.) Kopen- hagen 1906-1914.
33	Hx	"Huxley"	1909	Bulletin des résultats. Année 1908-09. (Cons. perm. internat.) Kopenhagen 1909.
34	J	"Ingolf"	1895-96	M. Knudsen, Hydrography. The Danish "Ingolf" Expedi- tion. Vol. I, Nr. 2. Kopenhagen 1899.
35	M	"Moltke"	1882	Annalen der Hydrographie usw. 1882, S. 741.
36	Ma	"Margrethe"	1913-14	Bulletin hydrographique. Année 1913-14. (Cons. perm. internat.). Kopenhagen 1915. J. P. Jacobsen, Contri- bution to the hydrography of the Atlantic. Medd elelser f. Komm. f. Havundersøgelser, Hydrografi, Bd. II, Nr. 5, Kopenhagen 1916.
37	Mo	"Modoc"	1925-26	International ice observations and ice patrol service 1925, 1926 (U. S. Treasury Department Coast Guard, Bull. 13, 15). Washington 1926, 1927.
38	Mö	"Möwe"	1911-12	G. Schott u. B. Schulz, Die Forschungsreise S. M. S. "Möwe." Aus dem Archiv der Deutschen Seewarte. 1914. H. 1. Hamburg 1914.
39	Mr	"Muirchu"	1925-30	Rapports et procès verbaux (Cons. perm. internat.). Bd. 40, 55, 70, 76. Rapport Atlantique 1925, 1927. Kopen- hagen 1926, 1929, 1931.
			1932	Bulletin hydrographique 1932. (Cons. perm. internat.) Kopenhagen 1933.
40	Ms	"Michael Sars"	1900-02	Bj. Helland-Hansen und F. Nansen, The Norwegian Sea. Kristiania 1909.
			1902	Bull. des résultats. (Cons. perm. internat.) Kopen- hagen 1903.
			1910	Bj. Helland-Hansen, Physical oceanography and meterol- ogy. Results of the "Michael Sars"-North Atlantic deep sea expedition 1910. Vol. I. Bergen 1930.
			1924	Rapports et procès verbaux. (Cons. perm. internat.) Bd. 56. Kopenhagen 1929.
41	Mt	"Meteor"	1925-27	G. Wüst u. a., Das ozeanographische Beobachtungsmaterial (Serienmessungen). Wiss. Ergebn. d. Deutschen At- lantischen Expedition auf dem Forschungs- und Ver- messungsschiff "Meteor" 1925-27. Bd. IV, Zweiter Teil. Berlin 1932.

NO.	ABREVI- ATION	SHIP	YEAR OF OBSERVATION	SOURCES AND REMARKS
				H. Wattenberg, Das chemische Beobachtungsmaterial und seine Gewinnung. Ebenda Bd. VIII, Berlin 1933.
			1929-30	Handschrift der Beobachtungen der Grönlandfahrten 1929/30, im Institut für Meereskunde Berlin.
42	Mv	"Marques de la Victoria"	1925	Rapports et procès verbaux (Cons. perm. internat.). Bd. 40. Kopenhagen 1926.
43	N	"National"	1889	O. Krümmel, Geophysikalische Beobachtungen. Ergebnisse der Plankton-Expedition. Kiel 1893.
44	Nr	"Norvegia"	1927-31	Handschriftliches Material des Geofysiske Institut in Bergen.
45	Pb	Portugiesische Bewachungsschiffe	1910-11	O. Pettersson, Einige Bemerkungen zu G. Schotts Geographie des Atlantischen Ozeans. (Internat. Revue d. ges. Hydrobiol. u. Hydrogr.) Leipzig 1913.
46	Pl	"Planet"	1906	W. Brennecke, Ozeanographie. Forschungsreise S. M. S. "Planet" 1906/07. Bd. III. Berlin 1909.
47	Pn	"Proserpina"	1926	Rapports et procès-verbaux (Cons. perm. internat.). Bd. 44, Kopenhagen 1927.
48	Pol	"Polaris"	1932	Bulletin hydrographique 1932. (Cons. perm. internat.) Kopenhagen 1933.
49	Pp	"Pourquoi pas?"	1909	J. Rouch, Océanographie physique. Deuxième expédition antarctique française. Paris 1913.
			1912-13	J. Charcot, Temperatures et salinités recueillis dans l'Atlantique, le Golf de Gascogne et la Manche occidentale. Annales hydrographiques 1921.
			1921-22	Rapports et procès-verbaux (Cons. perm. internat.). Bd. 29 u. 31. Rapport Atlantique 1921. Kopenhagen 1923.
50	Pr	"Princesse Alice"	1902-03	J. Thoulet, Mémoires océanographiques. I. Serie. Résultats des Campagnes Scientifiques, accomplies sur son Yacht par Albert Ier. Fasc. 29. Monaco 1905.
			1904	G. H. Allemandet, Analyse des échantillons d'eau de mer recueillis pendant la campagne du yacht "Princesse Alice" en 1904. Bull. de Musée océanographique de Monaco Nr. 43. 1905.
51	R	"Romanche"	1883	M. Martial, Sur les sondages effectués par le Romanche. Annales hydrographiques. Paris 1884.
52	Ra	"Rambler"	1895	List of oceanic depths 1895. Hydrographic Department Admiralty. London 1896.
53	Re	"Research"	1900	List of oceanic depths 1900 usw. London 1901.
54	Ry	"Rosemary"	1929-30	Bulletin hydrographique 1929 u. 1930. (Cons. perm. internat.) Kopenhagen 1930 u. 1931.
55	Sc	"Scotia"	1903-04	W. S. Bruce, The temperatures, specific gravities and salinities of the Weddell Sea and of the North and South Atlantic Ocean. Transactions of the Royal Society. Edinburgh Bd. 51, Teil I, Nr. 4. 1906.
			1913	Report on the work carried out by the S. S. Scotia 1913. London 1914.
56	St	"Stephan"	1911	Handschriftliches Material der Kabeldampferreise von Prof. A. Merz. Im Institut für Meereskunde Berlin.
57	T	"Thor"	1903	Bulletin des résultats. Année 1903-1904. Teil B (Cons. perm. internat.). Kopenhagen 1904.
			1904-05	J. N. Nielsen, Contribution to the hydrography of the north-eastern part of the Atlantic. Meddelelser fra Komm. f. Havundersøgelser, Serie Hydrografi. Bd. I, Nr. 9, Kopenhagen 1927.
			1906-10	Johs. Schmidt, Report on the Danish Oceanographical Expeditions 1908-1910 to the Mediterranean and adjacent seas. Vol. I. Kopenhagen 1912.
			1908	Bulletin des Résultats. Année 1907-08, Teil B (Cons. perm. internat.). Kopenhagen 1908.
58	Ta	"Tanche"	1923	Rapports et procès-verbaux. Bd. 35 (Cons. perm. internat.). Kopenhagen 1925.



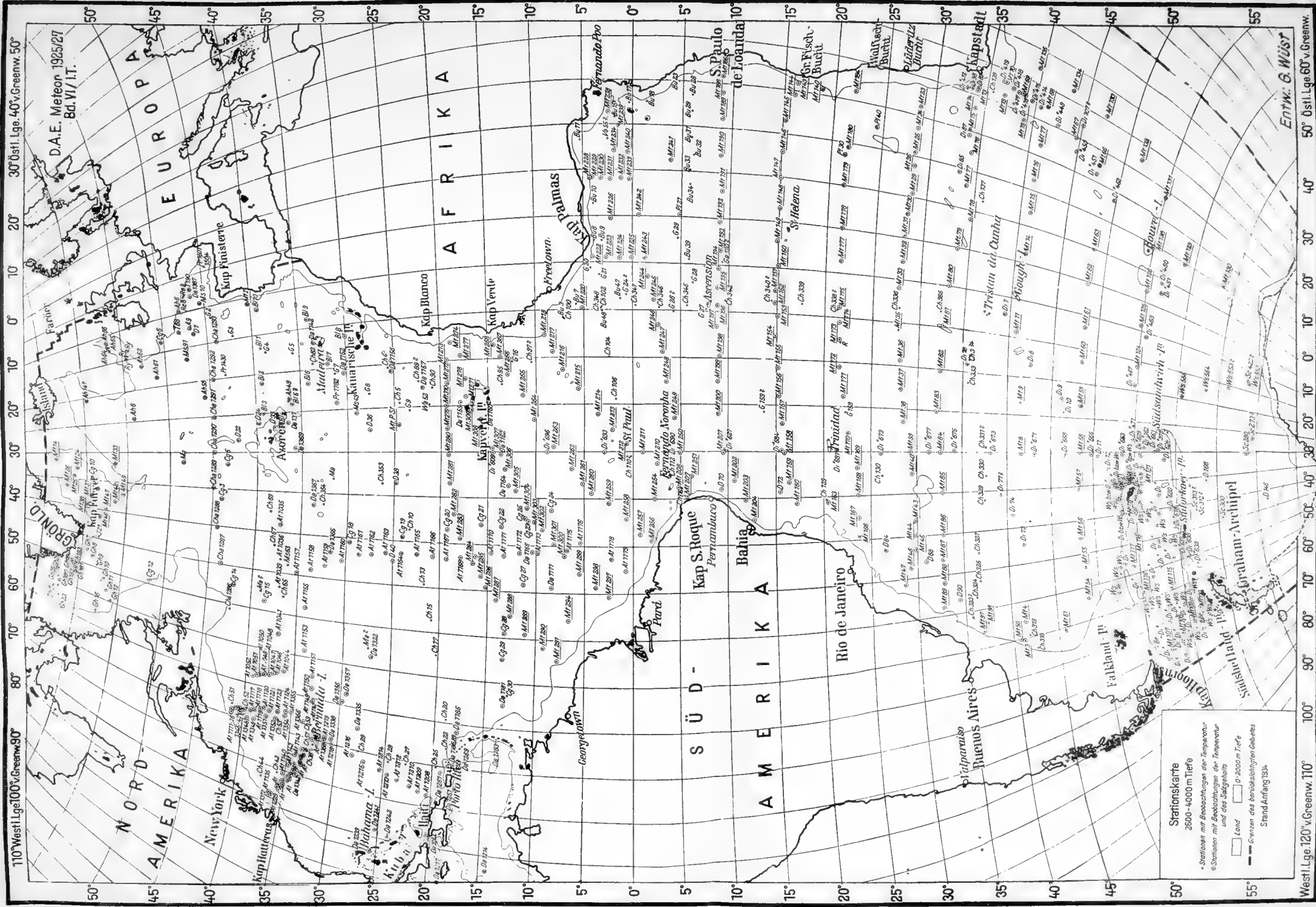
ATLANTIC OCEAN, TEMPERATURE, SALINITY AND DENSITY AT STANDARD DEPTHS, DEPTHS 200-1000 METERS





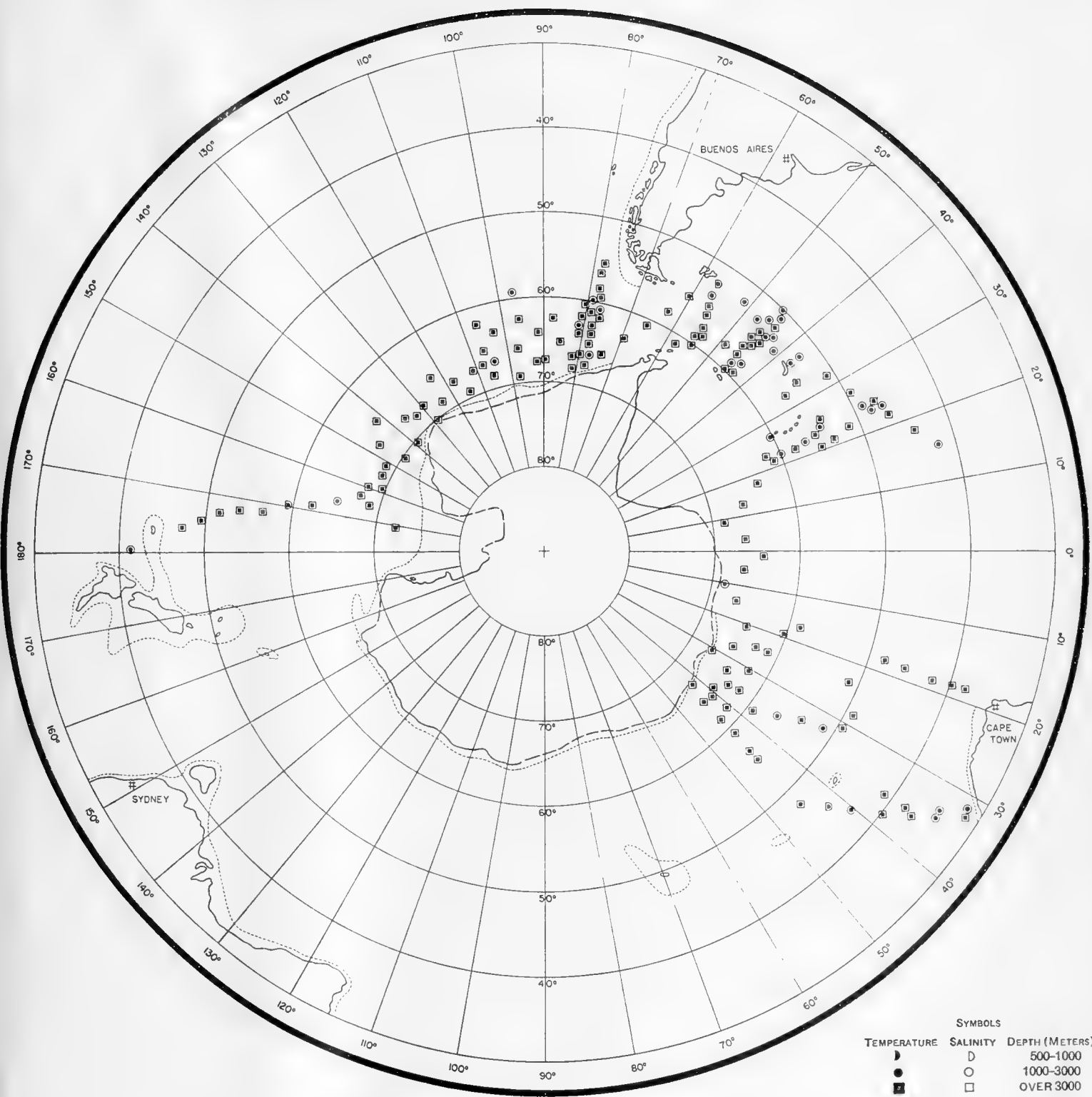
ATLANTIC OCEAN, TEMPERATURE, SALINITY AND DENSITY AT STANDARD DEPTHS, DEPTHS 1250-2000 METERS





ATLANTIC OCEAN, TEMPERATURE, SALINITY AND DENSITY AT STANDARD DEPTHS, DEPTHS 2500-4000 METERS





STATIONS OCCUPIED BY DISCOVERY II IN THE SOUTH ATLANTIC AND THE SOUTH PACIFIC, 1933-1935

11/17/68

NO.	ABREVI- ATION	SHIP	YEAR OF OBSERVATION	SOURCES AND REMARKS
59	Td	"Tadorne"	1925	Ebenda Bd. 40. Kopenhagen 1926.
60	Tp	"Tampa"	1925-29	International ice observation and ice patrol service. 1925 ff. (U.S. Treasury Department Coast Guard.) Washington 1926 ff.
61	V	"Vitiaz"	1886-89	Makaroff, Le Vitiaz et l'océan pacifique. St. Petersburg 1894.
62	Va	"Valdivia"	1898	G. Schott, Ozeanographie und maritime Meteorologie. Wiss. Ergebn. der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia." Jena 1902.
63	Vi	"Viking"	1913	Th. P. Funder, Hydrographic investigations from the Danish school ship Viking in the South Atlantic and Pacific. Meddelelser fra Komm. f. Havundersøgelser. Bd. II, Nr. 6. Kopenhagen 1916.
64	Vk	"Vikingen"	1929-30	Journal du Conseil (Cons. perm. internat.) Vol. V, Nr. 3. Kopenhagen 1930.
			1930	Hvalrådets Skrifter. Det Norske Videnskaps-Akademi Oslo Nr. 2. Oslo 1932.
65	Wa	"Waterwitch"	1894-95	List of oceanic depths 1894, 1895. Hydrographic Department Admiralty London 1895, 1896.
66	WS	"William Scoresby"	1926-27	Discovery Reports Vol. I, Station List 1925-1927. Cambridge 1929.
			1928-29	Discovery Reports Vol. III, Station List 1928-1929. Cambridge 1930.
			1929-31	Discovery Reports Vol. IV, Station List 1929-1931. Cambridge 1932.
67	X	"Xauen"	1930	Notas y resumas. Serie II. Nr. 39, 50, 51. Madrid 1930, 1931.
			1932	Bulletin hydrographique 1932 (Cons. perm. internat.). Kopenhagen 1933.
68	o. N.	Ohne Namensangabe	1927	Bulletin hydrographique 1927 (Cons. perm. internat.). Kopenhagen 1928 (schottisches Beobachtungsschiff).

## SERIAL SECTIONS OF TEMPERATURE AND SALINITY IN THE MEDITERRANEAN AND ADRIATIC SEAS

### MEDITERRANEAN SEA

#### PLATE 9

On the chart for the Mediterranean Sea a few stations are shown in the Adriatic but the work done by the Austrians and the Italians coöperatively between 1911 and 1914 was of such outstanding importance that a special chart of the Adriatic has been prepared on which the positions of those stations that were worked to depths of one hundred or more meters are shown. A list of the publications giving the results of these cruises is also hereto attached. In order to make the bibliography comprehensive a reference to a paper by Merz on hydrographic investigations in the Gulf of Trieste has been included.

Because of its dealing with the oceanographic features of the Mediterranean in general, mention is made of the paper by Prof. Gerhard Schott entitled "Die Gewässer des Mittelmeeres. Vorzugsweise nach den Arbeiten des dänischen Forschungs-

dampfers, THOR, 1918-1910."<sup>13</sup> As a few records were taken from this article, it is also cited in the list of sources of data.

#### Sources of Data

The sources of the data for the Mediterranean Sea plotted on the chart are as follows: (The letters after the ships' names are the abbreviations used on the chart.)

ADMIRANTE LOBO (AL): de Buen, Odón, Croisière océanographique du transport ADMIRANTE LOBO: Cons. Internat. Expl. Mer, Rapports, vol. 37, pp. 33-57, 1925.

ARMAUER-HANSEN (AH): Helland-Hansen, Bjørn, Avdeling A. Hydrografi: Det geofysiske Institutt, Særtrykk av Bergens Mus. Arsberetning, pp. 2-11, 1930-31.

DANA (D): DANA Expedition. List of Stations, DANA Report No. 1, pp. 17-78, seven plates, 1934. Stations 3520-3530, pp. 19, 20; stations 4026-4071, pp. 64-71. (The Carlsberg Foundation's Oceanographical Expedition Round the World 1928-1930, and previous DANA

<sup>13</sup> Ann. d. Hydr. usw. 1915. Heft 1, pp. 1-79, 8 plates.

Expeditions, under the leadership of Prof. Johannes Schmidt.)

EIDER and STÉNO (ES): Richard, J., and Sirvant, L., List des opérations faites dans les parages de Monaco à bord d'EIDER et du STÉNO pendant années 1907, 1908, 1909: Musée Océanogr. Monaco, Bull. 160, pp. 1-153, 1910.

GIRALDA (G): de Buen, Oden. Croisière de la GIRALDA (1920-21); Musée Océanogr. Monaco, Bull. 445, pp. 4-15, 1924.

HERTHA (HE): Luksch, Josef, und Wolf, Julius, Berichte der Commission für Erforschung des oestlichen Mittelmeeres: Akad. Wissensch. Wien, Denkschr., vol. 59, pp. 17-82, 1892.

NAJADE (N): Schott, Gerhard, Die Gewässer des Mittelmeeres: Hydrogr. und Marit. Meteorol. Annalen (1915), pp. 1-79, 1915.

NUÑEZ DE BALBOA (NB): de Buen, Oden, El Instituto Español de Oceanografía y sus primeras campañas por Oden de Buen: Trabajos de Oceanogr. y Biología Marina, Mem. no. 1, pp. 6-24, 1916.

POLA: Luksch, Josef, and Wolf, Julius, Berichte der Commission für Erforschung des oestlichen Mittelmeeres: Ak. Wissensch. Wien, Denkschr., Bd. 59, pp. 22-49, 1892; Bd. 60, pp. 91-108, 1893; Bd. 61, pp. 72-91, 1894.

THOR (T): Schmidt, Johannes, Danish oceanographical expeditions 1908-1910 to the Mediterranean and adjacent seas: Report, vol. 1, 1912.

XAUEN (X): de Buen, Rafael, Resultados obtenidos en las campañas del XAUEN por el Estrecho de Gibraltar en 1929: Inst. Español Oceanogr., Notas y Resúmenes, Serie 2, no. 39, pp. 1-27, 1930.

## ADRIATIC SEA

### PLATE 10

#### Sources of Data

CICLOPE (CI): See Italian publications in attached list.

NAJADE (NA): See Austrian publications in attached list.

#### Literature Especially on the Periodic Cruises by the Austrians on the NAJADE and by the Italians on the CICLOPE

Verein zur Förderung der naturwissenschaftlichen Erforschung der Adria in Wien.

Die erste Kreuzungsfahrt S. M. S. NAJADE in der Hochsee der Adria, 25. Februar bis 7. März 1911. Vorläufiger Bericht im Auftrage des Vereines zur Förderung der naturwissenschaftlichen Erforschung der Adria in Wien, erstattet von Prof. Dr. Ed. Brückner. K. k. Geograph. Gesellsch. in Wien 1911, Heft 4, 35 pp.

Bericht über zweite Kreuzungsfahrt S. M. S. NAJADE in der Hochsee der Adria, 16. Mai bis 4. Juni 1911. Im Auftrage etc., erstattet von Fregattenkapitän W. V. Kesslitz, Prof. Dr. A. Grund, Prof. Dr. C. I. Cori, *idem*, 1911, Heft 9, 19 pp.

Die dritte Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, 16. August bis 5. September 1911, etc., erstattet von Prof. Dr. Ed. Brückner, *idem*, Wien, 1912, Heft 1 u. 2, 37 pp.

Die vierte Terminfahrt S. M. S. NAJADE in der Hochsee

der Adria, 16. November bis 8. Dezember 1911, etc., erstattet von Prof. Dr. Alfred Grund, *idem*, 1912, Heft 4, 6 pp.

Die fünfte Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, 16. Februar bis 11. März 1912, etc., erstattet von Prof. Dr. Alfred Grund, *idem*, 1912, Heft 9 u. 10, S. 503-511.

Die sechste Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, 17. Mai bis 13. Juni 1912, etc., erstattet von Prof. Dr. Alfred Grund, *idem*, 1912, Heft 11 u. 12, S. 639-349.

Die siebente Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, 16. August bis 11. September 1912, etc., erstattet von Prof. Dr. Alfred Grund, *idem*, 1913, Heft 3, S. 164-176.

Die achte Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, vom 16. März bis 1. April 1913, *Idem* 1913, Heft 9 u. 10, S. 471-487.

Die neunte Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, vom 16. Mai bis 1. Juni 1913, Vorläufiger Bericht über die Fahrt und die hydrographischen Ergebnisse derselben im Auftrage des Vereines zur Förderung der naturwissenschaftlichen Erforschung der Adria in Wien, erstattet von Prof. Dr. Alfred Grund, *Idem* 1913, Heft 11 u. 12, S. 652-663.

Die zehnte, elfte und zwölfte Terminfahrt S. M. S. NAJADE in der Hochsee der Adria, in der Zeit vom 16. August 1913 bis 9. März 1914, Vorläufiger Bericht über die Fahrten und die hydrographischen etc., erstattet von Prof. Dr. Alfred Grund, *Idem* 1914, Heft 5 u. 6, 16 pp.

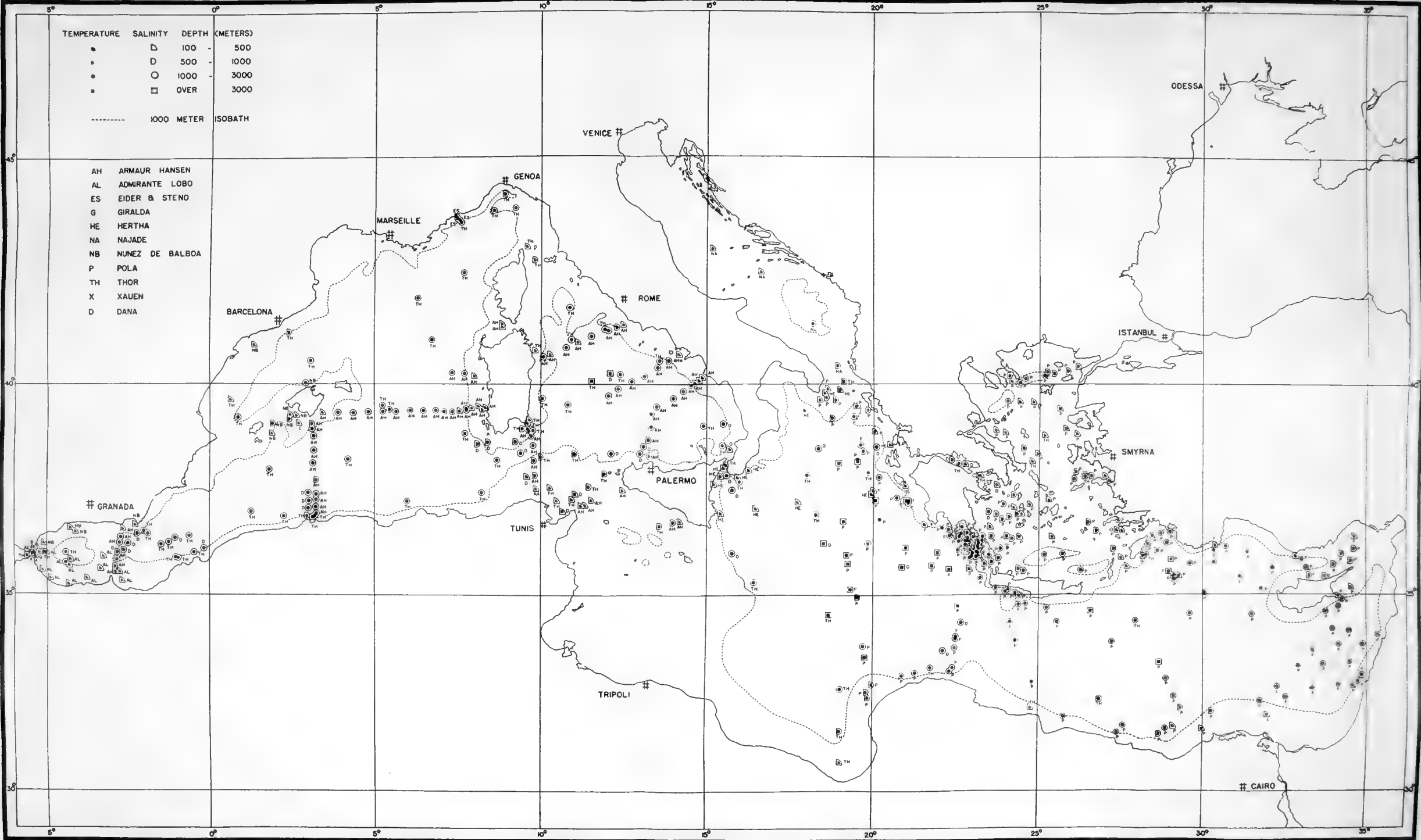
Hydrographische Untersuchungen im Golfe von Triest, von Dr. Alfred Merz. 11 Taf. 1. Karte, Kaiserl. Akad. Wissensch. Math.-Naturw. Kl., Band 87, 107 pp. Wien, 1911.

Permanente Internationale Kommission für die Erforschung der Adria.

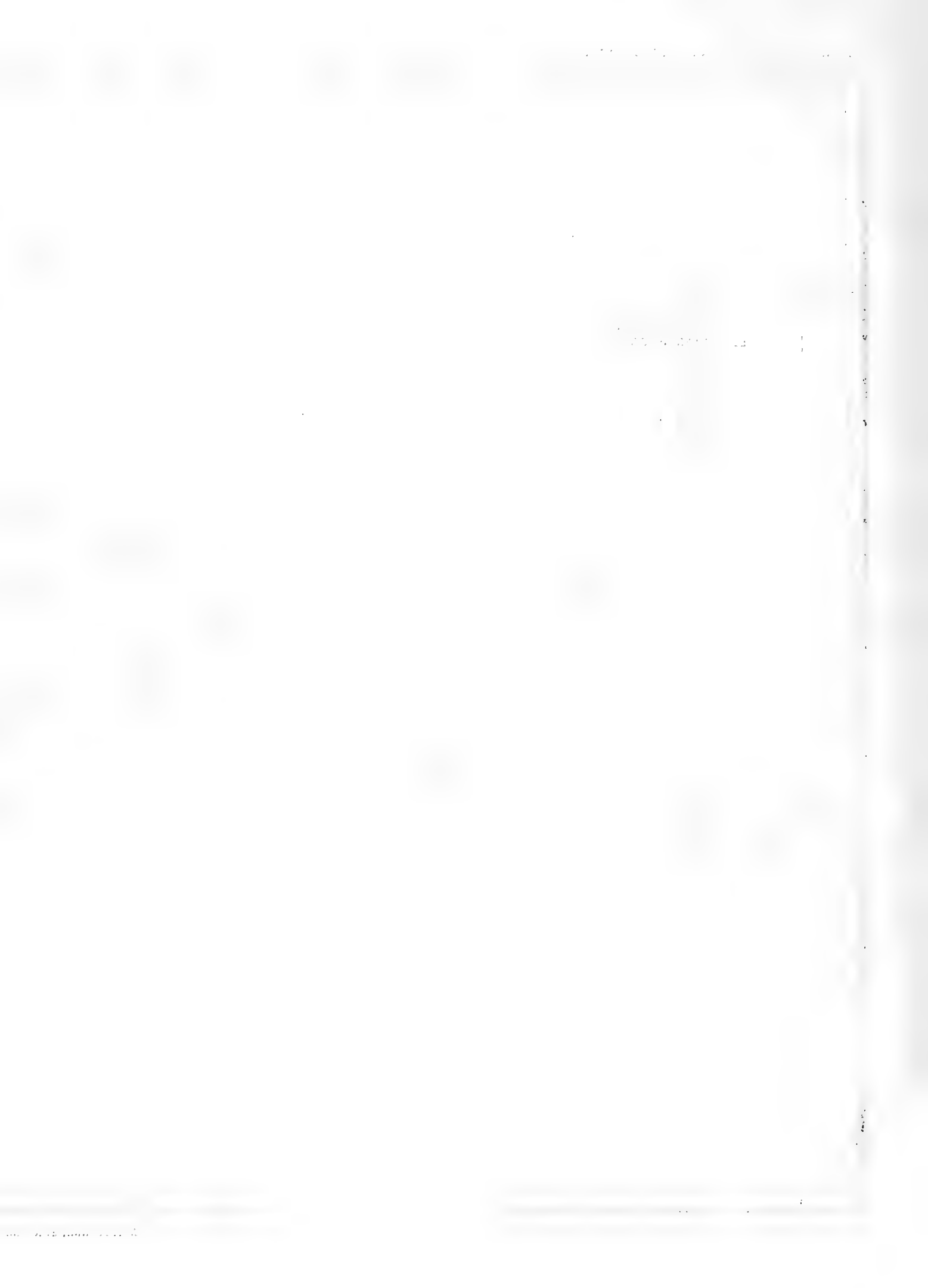
Berichte über die Terminfahrten. Österreichischer Teil, herausgegeben vom Verein zur Förderung der Naturwissenschaftlichen Erforschung der Adria in Wien, redigiert von Prof. Dr. Ed. Brückner, No. 1-4, Beobachtungen auf den Terminfahrten S. M. S. NAJADE im Jahre 1911. 1. Terminfahrt: 25. Februar bis 7. März 1911, S. 1; 2. Terminfahrt: 16. Mai bis 4. Juni 1911, S. 19; 3. Terminfahrt 16. August bis 5. September 1911, S. 47; 4. Terminfahrt: 16. November bis 8. Dezember 1911, S. 83-119. 1912. Tafel 1-4.

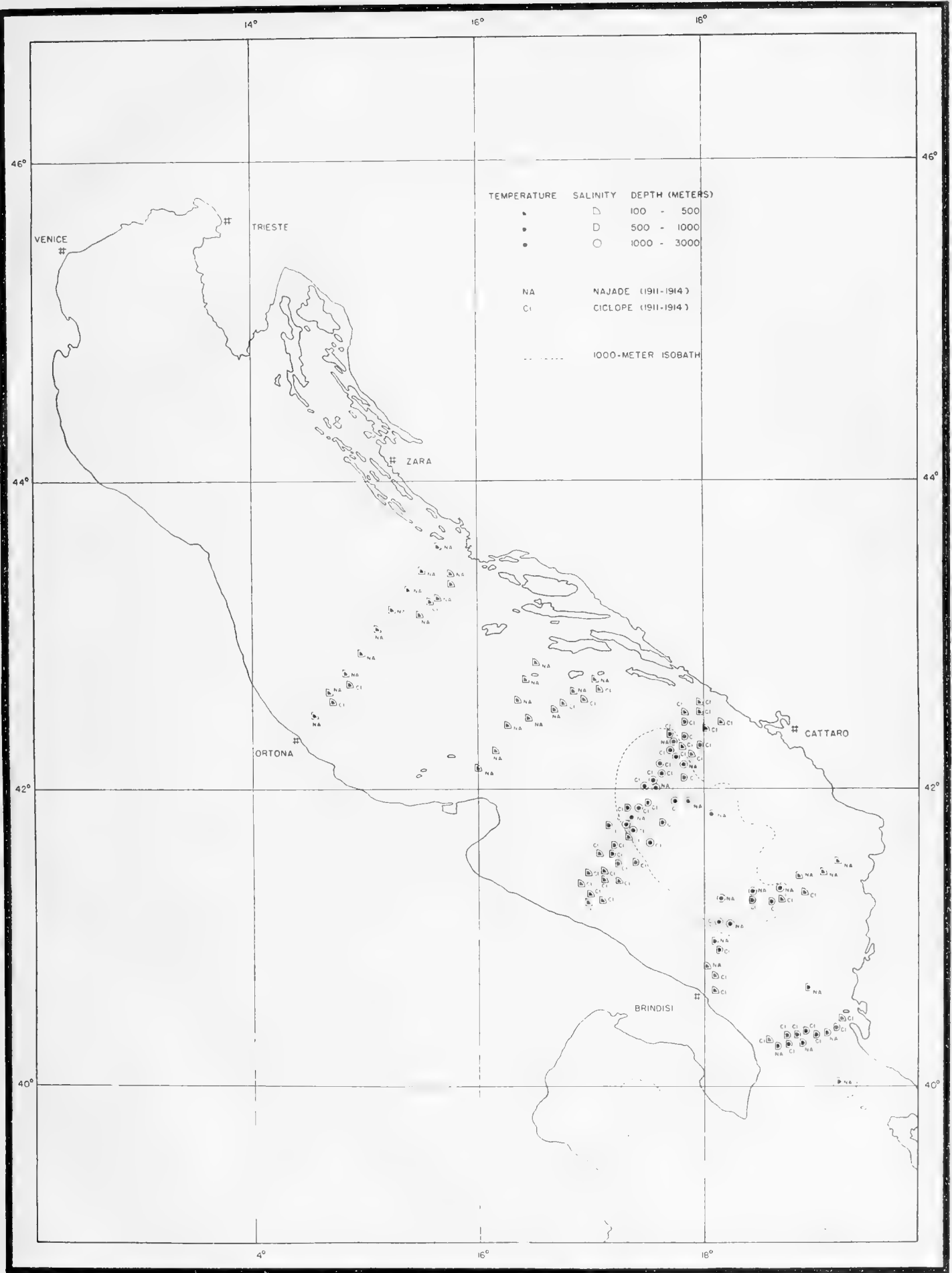
Berichte über die Terminfahrten. Österreichischer Teil, etc., . . . No. 5-7, Beobachtungen auf den Terminfahrten S. M. S. NAJADE im Jahre 1912. 5. Terminfahrt: 16. Februar bis 11. März 1912, S. 1; 6. Terminfahrt: 17. Mai bis 13. Juni 1912, S. 39; 7. Terminfahrt: 16. August bis 11. September 1912, S. 77-114. 1913. Tafel 1-3.

Berichte über die Terminfahrten. Österreichischer Teil, etc. No. 8-12, Beobachtungen etc. in den Jahren 1913 und 1914. 8. Terminfahrt: 16. März bis 1. April 1913, S. 1; 9. Terminfahrt: 16. Mai bis 1. Juni 1913, S. 21; 10. Terminfahrt: 16. August bis 1. September 1913, S. 41; 11. Terminfahrt: 16. November bis 6. Dezember 1913, S. 59; 12. Terminfahrt: 16. Februar bis 9. März 1914, S. 81-102, 1915. Tafel 1-4.



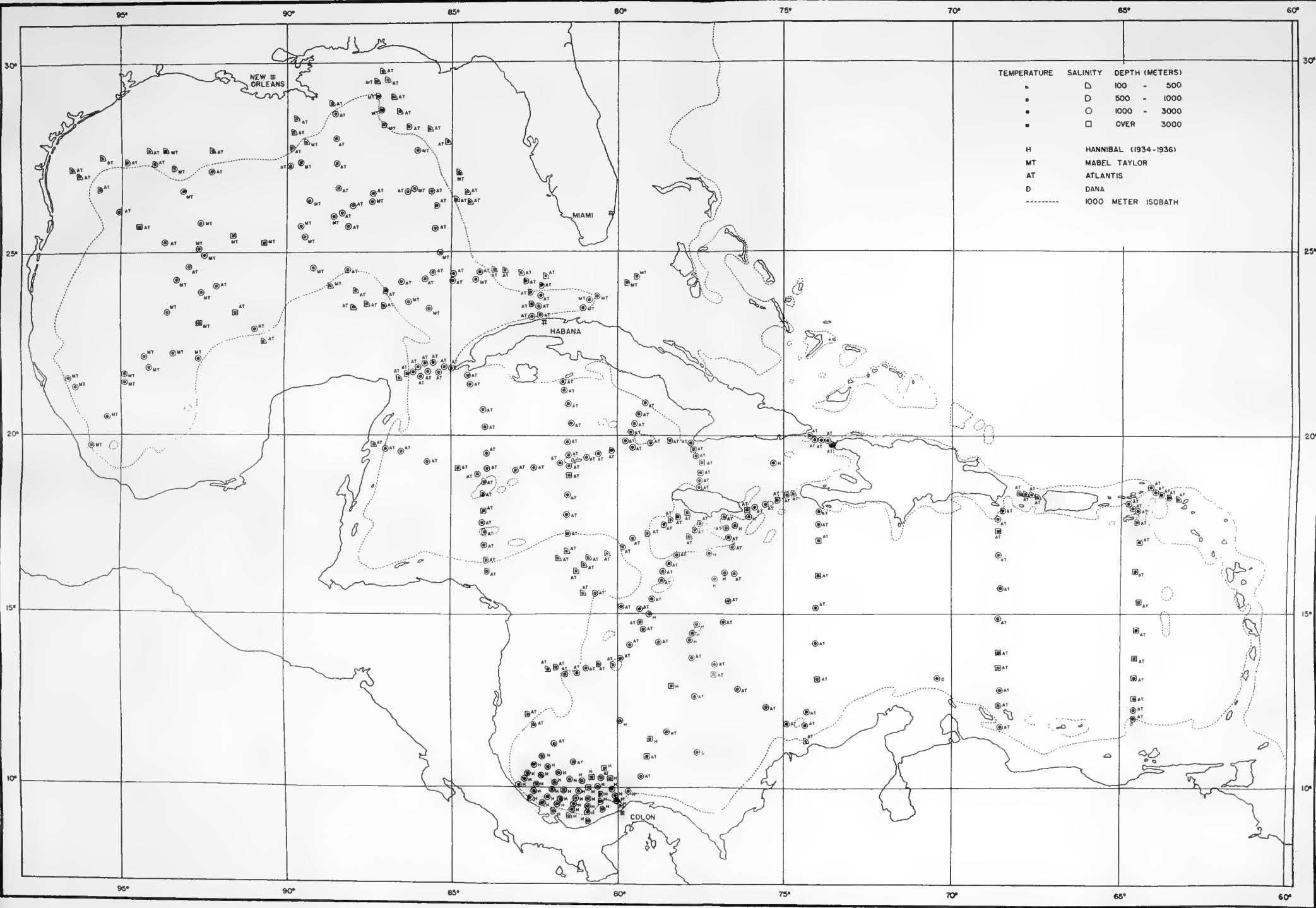
MEDITERRANEAN SEA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY





ADRIATIC SEA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY





GULF OF MEXICO AND CARIBBEAN SEA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY



*R. Comitato Talassografico Italiano.*

Risultati fisico-chimici delle prime cinque crociere Adriatiche (Agosto 1909-Febbraio 1911). Luigi di Marchi. Memoria III, Tab. pp. 83, 1-30, Tavole 1-11, 1911.

Risultati di esperienze con Galleggianti, per lo studio delle correnti del Mare Adriatico negli anni 1910-1914. Di G. Feruglio. Appendice. Le correnti dell'Adriatico secondo la distribuzione superficiale della salsedine e della temperatura. Di G. Feruglio e L. de Marchi (con 25 tavole ed 1 fotografia). Memoria LV, pp. v-xv, 1-129. 10 charts. 1920.

*Commissione internazionale permanente per lo studio dell'Adriatico.* Boll. delle Crociere Periodiche.

Ricerche Italiane eseguite dal R. Comitato Talassografico, Fasc. 1, Osservazioni fatte durante le 3 crociere della R. N. CICLOPE, 1. a (25 Febbraio-14 Marzo).—2. a (16 Maggio-11 Giugno)—3. a (17 Agosto-6 Settembre 1911) 53 pp., 1912.

Fasc. 2. Same title, 4. a (15-21 Agosto)—5. a (17 Novembre-16 Dicembre 1912). 41 pp., 1913.

Fasc. 3. Osservazioni fatte durante le 5 crociere della R. N. CICLOPE, 6a (26 Febbraio-9 Marzo 1913); 7a (14 Maggio-4 Giugno 1913); 8a (16-31 Agosto 1913); 9a (16-24 Novembre 1913); 10a (16 Febbraio-1 Marzo; 19 Marzo-30 April 1914). 93 pp., 1914.

# SERIAL SECTIONS OF TEMPERATURE AND SALINITY IN THE GULF OF MEXICO AND CARIBBEAN SEA

## PLATE 11

The stations in the Gulf of Mexico and the Caribbean Sea for serial sections of temperature and salinity shown on the accompanying chart were derived from three sources. First, Messrs. A. E. Parr and C. Iselin II, compiled on a chart the positions of all stations occupied by the MABEL TAYLOR and the ATLANTIS for the determinations of sub-surface temperatures and salinities. Reference is made to the two papers by Doctor Parr cited below.<sup>14</sup>

The next source of information is the United States Hydrographic Office and the Scripps Institution of Oceanography. The Hydrographic Office supplied information on the positions of the stations occupied by the U. S. S. HANNIBAL. Some of the chemical work on the water samples collected at the HANNIBAL stations in the Caribbean Sea was done at the Scripps Institution of Oceanography and from it some of the information incorporated on the chart was received.

The third source of information is the DANA

<sup>14</sup> Parr, A. E., Report on hydrographic observations in the Gulf of Mexico and the adjacent straits made during the Yale Oceanographic Expedition of the MABEL TAYLOR in 1932: Bingham Oceanographic Collection Bull., vol. 5, Art. 1, September, 1935.

Parr, A. E., A contribution to the hydrography of the Caribbean and the Cayman Seas. (Based upon the observations made by the Research Ship ATLANTIS, 1933-34.) Bingham Oceanographic Collections Bull., vol. 5, Art. 4, January, 1937.

Expedition in 1928. The title of the publication in which information on the stations is given is contained in the footnote below.<sup>15</sup>

On the chart the abbreviations for the different vessels are as follows:

ATLANTIS	(AT)
DANA	(D)
HANNIBAL	(H)
MABEL TAYLOR	(MT)

Some consideration was given as to whether stations occupied a number of years ago by the U. S. S. BLAKE should be included but it was decided that it was preferable to omit them. Although the BLAKE's temperature records appear trustworthy, as they were taken with Miller-Casella maximum-minimum thermometers, the depths records are not so accurate as those reported more recently by vessels that use unprotected thermometers for the determination of depths at which observations and collections are made. The older determinations of salinity by the use of hydrometers, in general, are not accurate enough for modern oceanographic work.

<sup>15</sup> DANA Expedition. List of Stations, DANA Report No. 1, pp. 17-78, seven plates, 1934. Stations 3804-3809, 3812-3973, pp. 45-60. (The Carlsberg Foundation's Oceanographical Expedition Round the World 1928-1930, and previous DANA Expeditions, under the leadership of Professor Johannes Schmidt.)

# PACIFIC OCEAN

## SERIAL SECTIONS OF TEMPERATURE AND SALINITY

PLATE 12, 13, 14A, 14B, 15, 16, 17

For the compilation here presented the chart entitled "Hydrographische Reihenmessungen seit 1870 im Stillen Ozean mit Beobachtungen von mehr als 1000 m. bzw. 3000 m.," published by Defant<sup>1</sup> is used as a base. The data indicated on Defant's chart have been used by Wüst<sup>2</sup> in his article cited in the footnote. Defant plotted on the chart published by him the data available in the Institut für Meereskunde up to February 1, 1928.

Subsequent to the date of publication, 1929, of the paper by Wüst, cited above, other important contributions to the knowledge of the oceanography of the Pacific Ocean have been published. Some of these are listed opposite the names of vessels that have conducted oceanographic expeditions in the Pacific during the past few years but a few others should be mentioned.

Attention will first be called to the monumental work of Gerhard Schott<sup>3</sup> entitled "Geographie des Indischen und Stillen Ozeans," published in Hamburg in 1935. This work, besides describing the general oceanographic features of the Pacific and presenting many excellently executed charts, contains numerous references to literature, and there are two chapters devoted to the history of exploration and research in the Indian and Pacific Oceans.

Another paper is entitled "A Report on Oceanographical Investigations in the Peru Coastal Current," by E. R. Gunther,<sup>4</sup> and a third is "The Hydrology of the Southern Ocean," by G. E. R. Deacon.<sup>5</sup>

Although an endeavor has been made to plot on the charts of the Pacific as many as possible

of the stations occupied for the subsurface determination of temperature and salinity, it is known that there are at least two deficiencies. More stations have been worked by the Japanese than have been put down on the charts. In addition to the stations which had already been plotted by Defant, there have been plotted stations occupied by the MANSYU in its operations between April, 1925, and March, 1928, as recorded in the list of sources from which information was taken. The report on the result of the operations of the MANSYU was published in 1933. There have also been added the stations occupied in the Japan Sea by the fisheries steamer SOYO MARU in 1932. The Japanese, however, have done much more oceanographic work than is shown by these stations. For references to the Japanese literature "The Records of Oceanographic Works in Japan," should be examined. In this series there are classified lists of papers and reports on oceanographic subjects published in Japan. The publications are classified under the captions "Physical and Chemical Oceanography," "Fundamental Marine Biology," and "Fisheries and Fisheries Technology." During recent years the Japanese have become very active in oceanographic research and their later work meets in its precision the requirements of modern oceanographic research.

Although the Russians have been active in oceanographic work in the northern part of the Sea of Japan, the Okhotsch Sea, and in the northwest Pacific east of Kamtchatka, records of the stations occupied have not been available for use in the preparation of this report except those for two vessels the KRASNY VIMPEL and the VOROVSKY. The names of both of these vessels are entered in the list of the sources of data and references are given to the U. S. S. R. Hydrometeorological Observations of Hydrographic Expeditions.

Except the deficiencies above enumerated it is hoped that the records of the sources of data are practically complete.

<sup>1</sup> Defant, A., Die systematische Erforschung des Weltmeeres: Gesellsch. für Erdk. Berlin. Zeitsch., Jubiläums-Sonderband, 1928, pp. 459-505, pl. 32, figs. 18-31.

<sup>2</sup> Wüst, Georg, Schichtung und Tiefenzirkulation des Pazifischen Ozeans: Institut für Meereskunde, Berlin, N. F., A. Geograph.-Naturwissensch. Reihe, Heft 20, pp. 1-64, 4 pls., 14 figs., 1929.

<sup>3</sup> Pp. xix, 413, 114 text figs., 37 pls., Section on bottom deposits by W. Schott, and a chapter on life in the Indian and Pacific Oceans by E. Hentschel.

<sup>4</sup> DISCOVERY Reports, vol. 13, pp. 107-276, pls. 14, 16, 1936.

<sup>5</sup> DISCOVERY Reports, vol. 15, pp. 1-124, pls. 1-44, 1937.

Comment should be made on the data taken from the manuscript records of several of the vessels. The final reports on the operations of the *CARNEGIE* in the Pacific are now in press as publications of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Not only the details of the observations made at the stations will soon become available in print but also the scientific interpretations. Dr. Harald U. Sverdrup has had charge of the preparation of the reports on the physical oceanography.

The hydrological results of *DISCOVERY I* under the direction of Sir Douglas Mawson will also soon be in print. The interpretation of the hydrological data has been undertaken by Doctor Sverdrup who has prepared that section of the report. The report on the results of *DISCOVERY I* will deal with the southwest corner of the Pacific and will extend entirely across the southern Indian Ocean.

The records of stations occupied by *DISCOVERY II* and the *WILLIAM SCORESBY* were sent to me in the form of a manuscript chart by Dr. Stanley Kemp, without distinction between the stations occupied by each vessel. The chart did not indicate the depth to which scientific observations and collections were made, and I have not yet seen any pub-

lished lists of those stations, but I have seen copies of the station lists for the south Atlantic Ocean. Therefore on the chart of the Pacific and also on that of the Indian Ocean for the stations occupied by the *DISCOVERY II* and the *WILLIAM SCORESBY* a triangle, without indication of depth, has been used to indicate the positions of the stations, instead of other symbols that give definite depths. Dr. Stanley Kemp also sent me manuscript charts showing the positions of the stations occupied by the *WILLIAM SCORESBY* off the west coast of South America. For some of the stations the depth to which observations and collections were made were indicated but not for quite all of them. Therefore for those stations for which information is not complete the same kind of a triangle has been used as that used for the stations of the *DISCOVERY II* and the *WILLIAM SCORESBY* around the Antarctica for which information on depths was not available. It may be confidently expected that the station lists for the *DISCOVERY II* and the *WILLIAM SCORESBY* will, before a great while, become available in print. The two papers by Messrs. Gunther and Deacon, cited above, used information derived from the work of the *DISCOVERY II* and the *WILLIAM SCORESBY* in the south Pacific.

#### SOURCES OF DATA FOR THE NORTH PACIFIC OCEAN

##### *Listed by A. Defant*

NAME OF SHIP	TIME OF WORK	POSITION OF STATION	SOURCES OF DATA
<b>TUSCARORA</b>	1873	34-54°N, 121-130°W	Makaroff, <i>Le VITIAZ et l'Océan pacifique</i> , Petersburg 1894. Note: The original source, G. E. Belknap, Deep sea soundings in the North Pacific Ocean, obtained by U. S. S. <i>TUSCARORA</i> , Washington 1874, U. S. Hydrographic Office Nr. 54 could not be examined nor could the manuscript of the serial temperature on the voyage Hawaii-Phoenix Islands, Fiji Islands 1875-76.
	January/April 1874	20-29°N, 144°W-160°E	
	June 1874	41-44°N, 145-150°E	
	July/August 1874	51-54°N, 153°W-168°E	
<b>CHALLENGER</b>	October/Nov. 1874 & } January 1875	0-17°N, 117-126°E	The Report of the Scientific Results of the voyage H. M. S. <i>CHALLENGER</i> during the years 1873-1876, vol. 1, Physics and Chemistry, London 1884, pls. 123, 124, 126-129, 132, 134, 148, 150, 180.
	February 1875	4-6°N, 124-130°E	
	March 1875	2-19°N, 141-146°E	
	April, June, July 1875	22-38°N, 137°E-160°W	
	August 1875	20°N, 157°W	
<b>GAZELLE</b>	June/July 1875	0-2°N, 134-147°E	Forschungsreise S. M. S. <i>GAZELLE</i> , hrsg. vom Reichsmarineamt, Physik und Chemie, Bd. 2, Berlin 1888/89, p. 40.
<b>ELISABETH</b>	February 1878	27°N, 140°W	Kapitän z. S. Wickede, Tiefseebeobachtungen S. M. S. <i>ELISABETH</i> , Annalen der Hydrographie 1878, p. 319.
<b>RAMBLER</b>	June/July 1890	2-20°N, 115-125°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1890, London 1891, pp. 10, 11.

## INTERNATIONAL ASPECTS OF OCEANOGRAPHY

NAME OF SHIP	TIME OF WORK	POSITION OF STATION	SOURCES OF DATA
ALBATROSS	February/April 1891	0-10°N, 78-96°W	C. H. Townsend, Report of the U. S. Fish Commission for 1900, Washington 1901, p. 495.
PENGUIN	November/Dec. 1891 April/May 1892	0-19°N, 115-126°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1891, London 1892, pp. 10, 11.
ALBATROSS	August 1893 August 1895	54-56°N, 172-175°W 54-55°N, 167-172°W	C. H. Townsend, Report of the U. S. Fish Commission for 1900, Washington 1901, pp. 498-500.
PENGUIN	May/September 1897	0-18°N, 152-166°W	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1897, London 1898, pp. 44-45.
EGERIA	June 1899	42-46°N, 128-132°W	Ibid 1899, London 1900, pp. 16-17.
WATERWITCH	July 1901	15°N, 118°E	Ibid. 1902, London 1903, pp. 16-17.
ALEXANDER	June/August 1911 and February 1913	32-33°N, 117-120°W	E. L. Michael and G. F. McEwen, Hydrographic, plankton and dredging record of the Scripps Institution for biological Research of the University of California 1901-1912, University of Cal. Publications, Zoology 1915-1916, vol. 15, Berkeley 1916 und Continuation 1913-1915, Ibid., vol. 15, No. 2.
MANSYU	October/Nov. 1927	25-34°N, 128-146°E 10-30°N, 122-137°E	Hydrogr. Department Tokyo, Hydrogr. Bulletin Tokyo, from 1925.

## SOURCES OF DATA FOR THE SOUTH PACIFIC OCEAN

*Listed by A. Defant*

CHALLENGER	June 1874 July 1874 August 1874 September 1874 February/March 1875 September 1875 October 1875 November/Dec. 1875	34-39°S, 154-166°E 25-40°S, 177°E-172°W 12-19°S, 146-178°E 5-6°S, 130-134°E 0-2°S, 138-147°E 0-17°S, 149-151°W 23-40°S, 112-149°W 33-45°S, 73-105°W	Report of the scientific Results of the voyage H. M. S. CHALLENGER during the years 1873 to 1876, vol. 1, Physics and Chemistry, London 1884, pls. 103, 105, 106, 108, 109, 111-113, 116, 119, 121, 122, 137-139, 190, 197, 201, 206, 209-213, 215, 216, 218, 219, 221, 222.
GAZELLE	May/June 1875 Oct. 1875/Nov. 1875 December 1875 January 1876	2-7°S, 125-130°E 19-34°S, 156-179°E 14-18°S, 168-178°W 22-51°S, 80-165°W	Die Forschungsreise S. M. S. GAZELLE, hrsg. vom Reichsmarineamt, Physik und Chemie, vol. 2, Berlin 1888/89, pp. 40, 42.
EGERIA	December 1887 June/August 1888 Nov. 1888-June 1890	37-39°S, 133-138°E 22-34°S, 175°W-178°E 12-29°S, 173°W-176°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths, 1888, pp. 2-5; 1889, pp. 14, 15; 1890, pp. 10, 11, London 1889, 1890, 1891.
MYRMIDON	November/Dec. 1888	5-8°S, 129-131°E	Ibid. 1888, London 1889, pp. 4, 5.
RAMBLER	June 1890	0-3°S, 126-131°E	Ibid., 1890, London 1891, pp. 10, 11.
ALBATROSS	26 March 1891	0°20'S, 85°8'W	C. H. Townsend: Report of the U. S. Fish Commission for 1900, Washington 1901, p. 495.
PENGUIN	August/Sept. 1894 February-August 1895	12-21°S, 155-161°E 10-35°S, 153°E-174°W	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1894, pp. 10, 11; 1895, pp. 16, 17, London 1895/96.
WATERWITCH	May/December 1895 May/June 1896	11-39°S, 154°E-176°W 21-33°S, 153-170°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1895, pp. 20-21; 1896, pp. 16, 17, London 1896/97.
PENGUIN	July 1896 November 1896 December 1896 May 1897 September 1897 November 1897	8°S, 179°E 26°S, 177°E 40°S, 160°E 1-13°S, 168°W-176°E 1-11°S, 163-173°W 21°S, 150-179°E	Ibid., 1896, pp. 16, 17; 1897, pp. 42, 43; 1898, pp. 14, 15; 1899, pp. 18, 19; 1900, pp. 30, 31; 1903, pp. 20, 21; London, 1897 to 1901, 1904.

NAME OF SHIP	TIME OF WORK	POSITION OF STATION	SOURCES OF DATA
EGERIA BELGICA	December 1898	22-33°S, 157-175°W	Ibid., 1897, London 1898, pp. 48, 49. H. Arctowski und H. R. Mill, Oceanographie, Relations thermiques, Expedition Antarctique Belge. Résultats du voyage du S. Y. BELGICA 1897-99, Antwerpen 1908, p. 35. Hydrogr. Department of the Admiralty, List of Oceanic Depths 1904, London 1905, pp. 17-25. A. Agassiz, General Report of the Expedition to the Eastern Tropical Pacific. Report on the scientific Results, Vol. 5, Memoir of the Museum of Comparative Zoology at Harvard College, Cambridge 1906, p. 24. Die Forschungsreise S. M. S. PLANET, hrsg. vom Reichsmarineamt, vol. 3, Berlin 1909, p. 61. Salzgehaltsbestimmungen aus dem südwestlichen Stillen Ozean, Annalen der Hydrographie 1909, 491. (Compiled by Hans H. F. Meyer.)
	January 1900	43-44°S, 143-144°E	
	April 1902	31-34°S, 154-177°E	
	Sept./Oct. 1897	17-24°S, 72-74°W	
	19 February 1899	70°30'S, 94°12'W	
DISCOVERY	8 January 1902	70°10'S, 173°22'E	
ALBATROSS	Nov. 1904/Febr. 1905	4-22°S, 79-133°W	
PLANET	October 1906	3°S, 151°E	
PLANET	June/September 1908	1-14°S, 147-156°E	

#### SUPPLEMENTAL SOURCES OF DATA ON THE PACIFIC OCEAN

The positions of the stations plotted by Defant are without abbreviations. There were plotted with abbreviations on Defant's chart and on more de-

tailed charts of certain areas, the positions of stations, of dates mostly subsequent to February 1, 1928. A list of the sources of data for the stations that were added is as follows: (The letters following the names are the abbreviations used on the charts.)

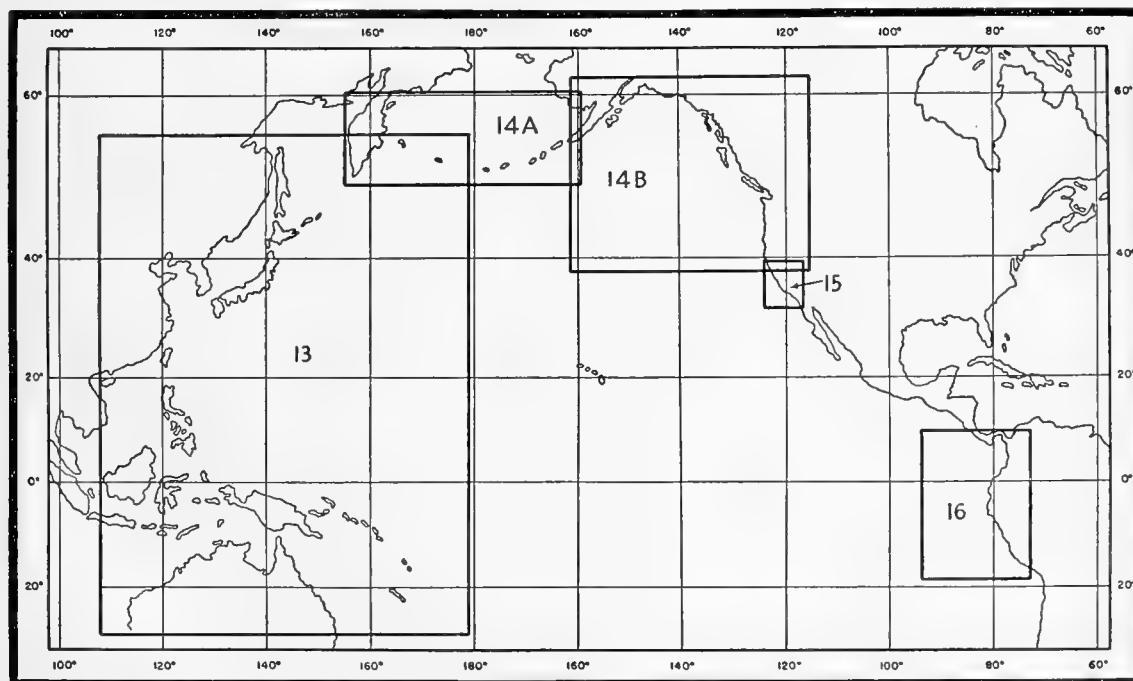
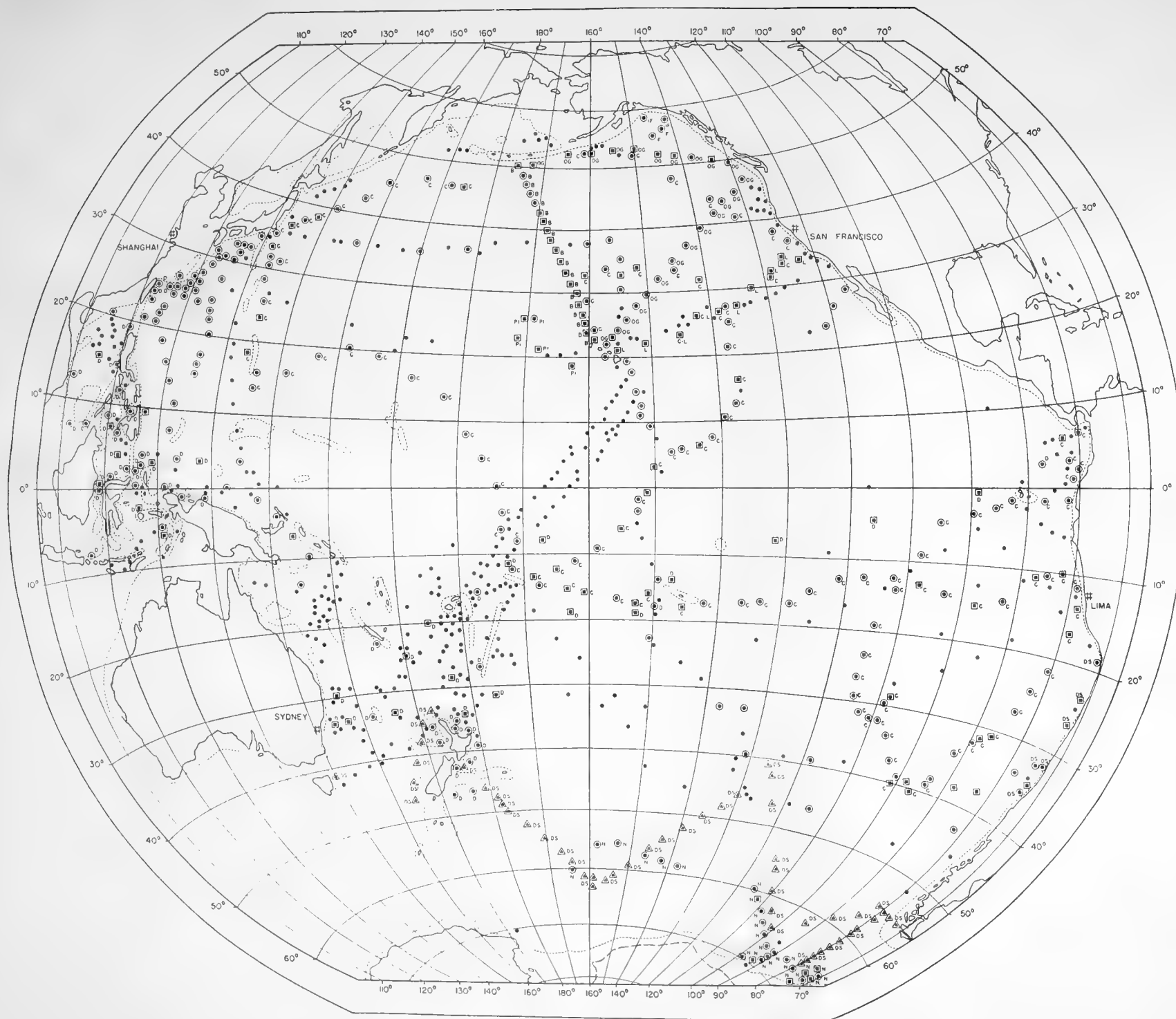


FIG. 1. KEY CHART TO SHOW THE POSITIONS OF FIVE SPECIAL CHARTS  
PLATES 13, 14A, 14B, 15, 16, OF AREAS IN THE PACIFIC

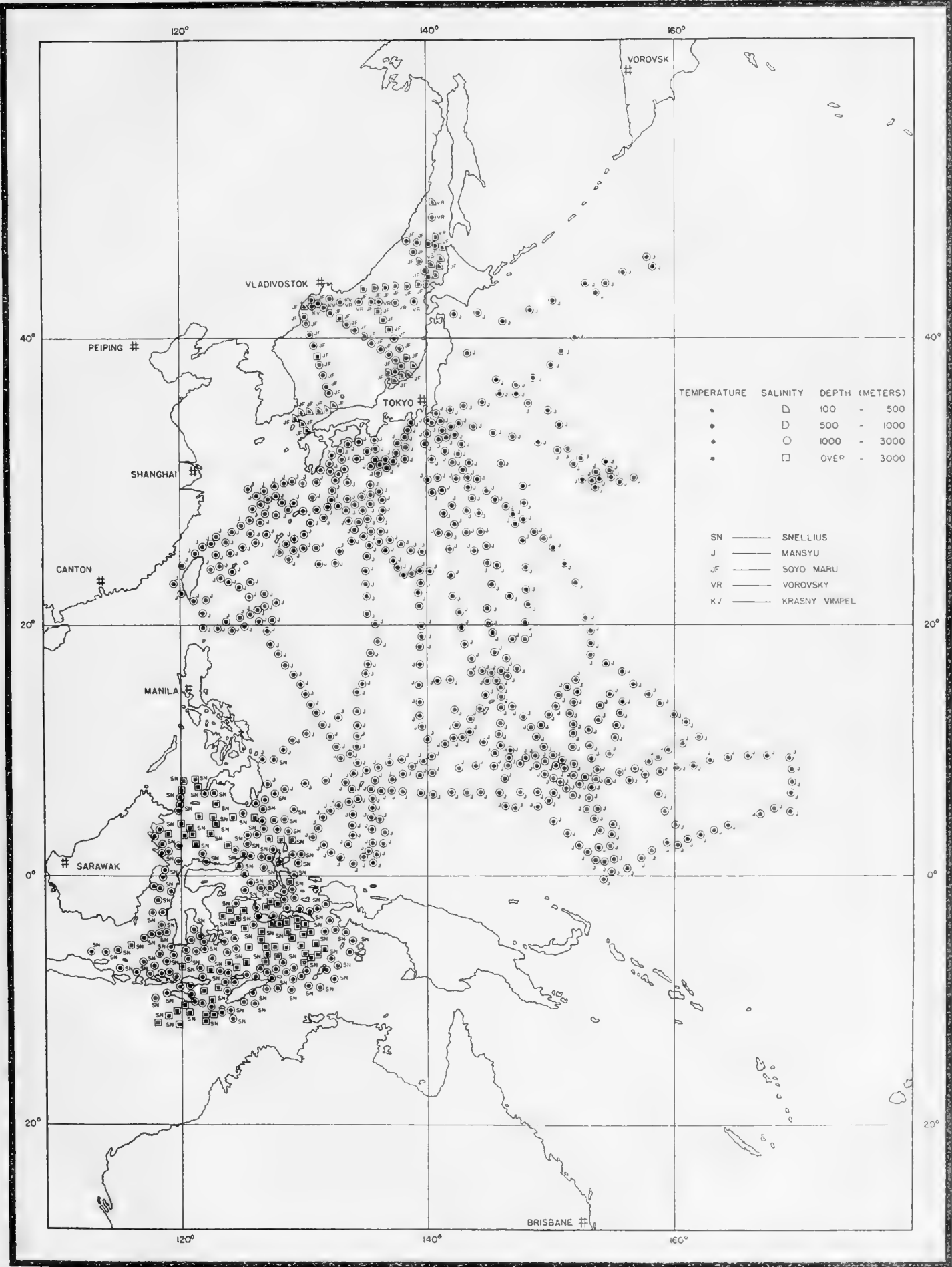
- ALBACORE (A): Bigelow, Henry B., and Leslie, Maurine, Reconnaissance of the waters and plankton of Monterey Bay, July, 1928: Mus. Com. Zool., Harvard Coll., vol. 70, No. 5, pp. 430-581, 1930.
- ALBATROSS (F): Manuscript at Scripps Institution of Oceanography.
- BUSHNELL (B): Manuscript records from U. S. N. Hydrogr. Off. and Scripps Institution of Oceanography.
- CARNEGIE (C): Manuscript from Dr. John A. Fleming, Dept. Terres. Mag., Carnegie Inst. of Washington. (Reports in press.)
- CATALYST (CT): Manuscript from Dr. T. G. Thompson, Oceanographic Laboratories, University of Washington.
- CHELAN (CH): Zeusler, F. A., Thompson, T. G., and others, Report of Oceanographic Cruise, U. S. Coast Guard Cutter CHELAN, Bering Sea and Bering Strait, 1934: U. S. Coast Guard special mimeographed publication June, 1936, pp. 72, many plates and tables.
- DANA (D): Schmidt, Johannes. Manuscript from Dr. Helge Thomsen. Subsequently published. List of Stations, DANA Report No. 1, pp. 17-78, seven plates, 1934. Stations 3548-3803, pp. 21-45; stations 3810-3811, p. 45. (The Carlsberg Foundation's Oceanographical Expedition Round the World 1928-1930, and previous DANA Expeditions, under the leadership of Prof. Johannes Schmidt.)
- DISCOVERY I (DI): Manuscript from Sir Douglas Mawson. Reports in press.
- DISCOVERY II and WILLIAM SCORESBY (DS): Around Antarctica and off the west coast of South America. Manuscript from Dr. Stanley Kemp.
- DISCOVERY II: Manuscript from Dr. N. A. Mackintosh. Across the south Atlantic and south Pacific, and western Indian Oceans, 1933-35. Special chart. No abbreviation for name.
- GANNETT (G): Manuscript records from U. S. N. Hydrogr. Off.
- GUIDE (GU): Manuscript, data from U. S. C. and G. S. at Scripps Institution of Oceanography.
- HANNIBAL (H): Manuscript U. S. S. HANNIBAL data 1932-1936, through U. S. Hydrographic Office and Scripps Institution of Oceanography. Part of data published. Dynamic Oceanographic Data for the central eastern Pacific Ocean, Collected by U. S. S. HANNIBAL and the yacht VELERO III. U. S. Navy Hydrographic Office publication H. O. 212, pp. V, 1-41, 1934.
- International Fisheries Commission (IF): McEwen, George F., Thompson, Thomas G. and Van Cleve, Richard. Hydrographic sections and calculated currents in the Gulf of Alaska 1927-1928: Internat. Fish. Comm. Report No. 4, pp. 5-36, 1930. Manuscript, data from Internat. Fish. Comm. Subsequently published.
- Thompson, T. G., McEwen, G. F., and Van Cleve, R. Hydrographic Sections and Calculated Currents of the Gulf of Alaska, 1929. Internat. Fish. Comm. Report, No. 10, pp. 32, 1936.
- KRASNY VIMPEL (KV): U. S. S. R. Hydrometeorological Observations of Hydrographic Expeditions, 1926, Issue No. 6, pp. 46-48.
- LOUISVILLE (L): Manuscript records from U. S. N. Hydrogr. Off. and Scripps Institution of Oceanography.
- MANSYU and other Japanese vessels (J): The report of oceanic survey in western part of the North Pacific Ocean carried out by H. J. M. S. MANSYU from April 1925 to March 1928: Hydrogr. Dept., Imperial Jap. Navy Bull. vol. 6, text pp. 496, 1933, Charts, vol. 6, pls. 135, 1933.
- NORWEGIA (N): Manuscript from Håkon Mosby and J. K. Eggvin through Prof. H. U. Sverdrup. Records of a considerable number of stations are contained in Mosby, Håkon, The waters of the Atlantic Antarctic Ocean: Norwegian Antarctic Expedition, 1927-28 et seq., instituted and financed by Consul Lars Christensen, Scient. Results, No. 11, Det Norske Videnskaps-Akademi i Oslo, Oslo 1934; Rustad, A., Antarctic Enphausiids from the NORWEGIA Expeditions, 1929-30, 1930-31, Norw. Antart. Exped. Scien. Results, no. 12.
- OGLALA (OG): Manuscript records from U. S. N. Hydrogr. Off.
- PIONEER (PI): Manuscript data U. S. Coast and Geodetic Survey at Scripps Institution of Oceanography.
- SCRIPPS (SC): Michael, Ellis L., and McEwen, George F., Hydrographic, plankton, and dredging Records: University of California Publication in Zoology, vol. 15, no. 1, pp. 1-206, July 15, 1915; and vol. 15, no. 2, Nov. 29, 1916, pp. 207-254. Manuscript data at Scripps Institution of Oceanography.
- Skogsberg (SK): Manuscript data from Dr. T. Skogsberg.
- SOYO MARU (JF): Uda, M., Hydrographical studies based on simultaneous oceanographical surveys made in the Japan Sea and in its adjacent waters during May and June, 1932. Records of Oceanographic Works in Japan, vol. 6, no. 1, pp. 19-107, March, 1934.
- VOROVSKY (VA): U. S. S. R. Hydrometeorological observations of hydrographic expeditions, 1926, Issue no. 6, pp. 45-46.
- WILLEBRORD SNELLIUS (SN): van Everdingen, E. The SNELLIUS Expedition. Conseil International pour l'Exploration de la Mer, Journal vol. 5, no. 3, pp. 320-328, 1930. van Riel, P. M. "Derde Bulletin van de WILLEBRORD SNELLIUS Expeditie, pp. 1-12, Indisch Comité voor Wetenschappelijke Onderzoekingen.
- WILLIAM SCORESBY (S): Manuscript data from Dr. Stanley Kemp.



## PACIFIC OCEAN, GENERAL CHART

Serial Sections of Temperature and Salinity. Stations without Abbreviations, after A. Defant, up to February 1, 1928. Stations with Abbreviations, subsequent to that date.

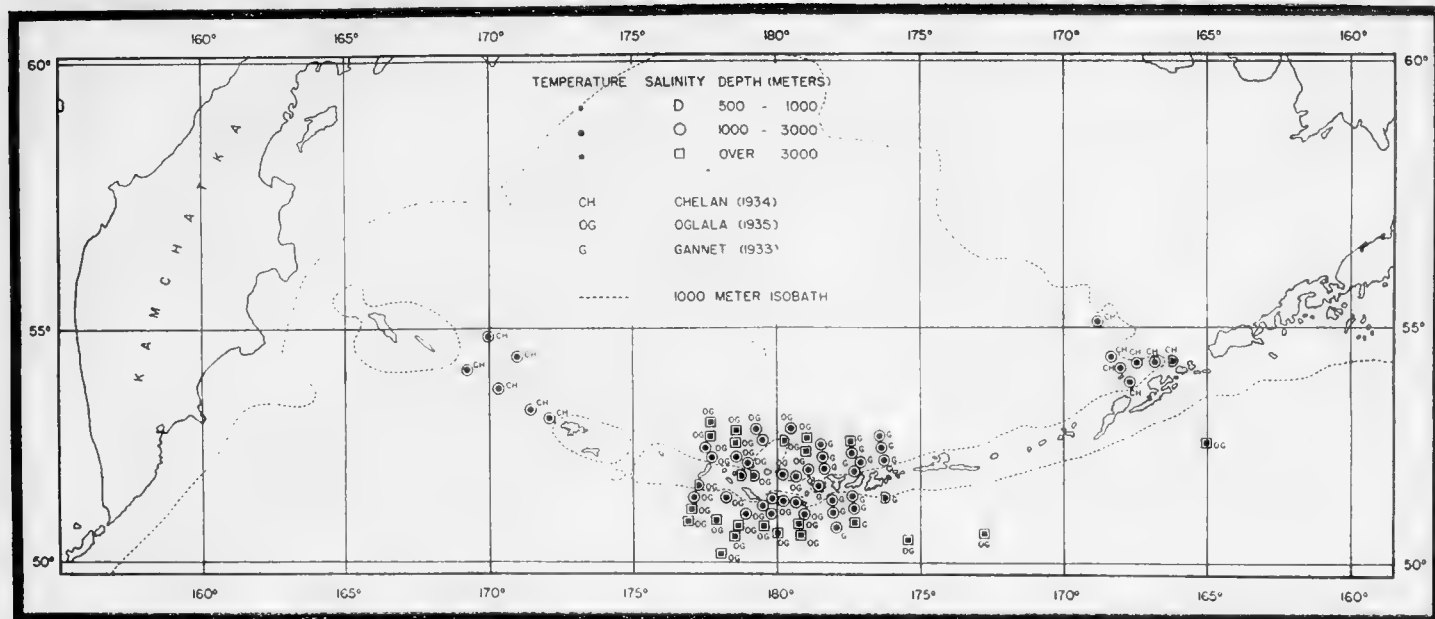




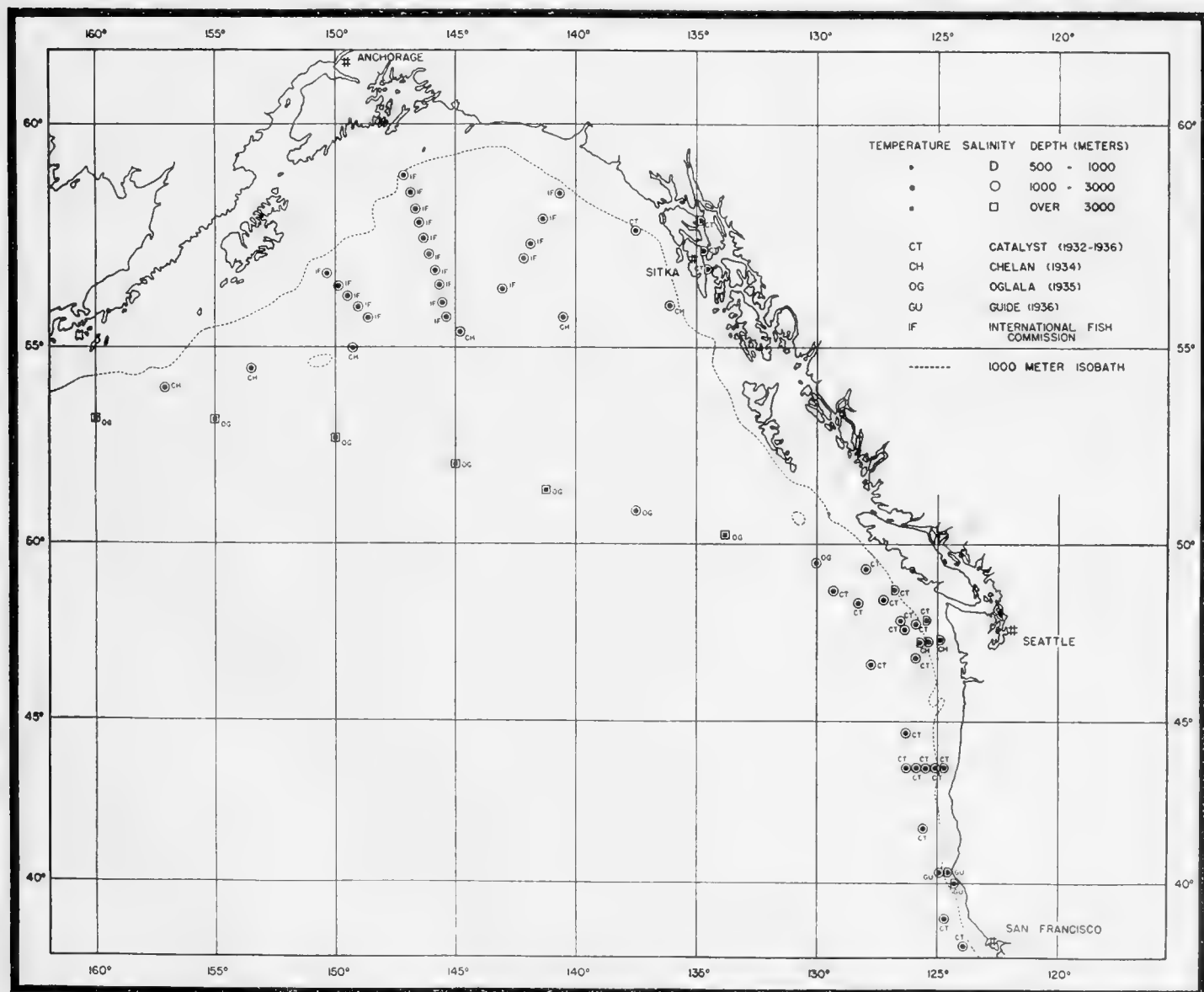
JAPANESE ISLANDS TO EAST INDIES, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

# CONTENTS

1997  
1998  
1999



A. OCEANIC AREAS ADJACENT TO THE ALEUTIAN ISLANDS, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

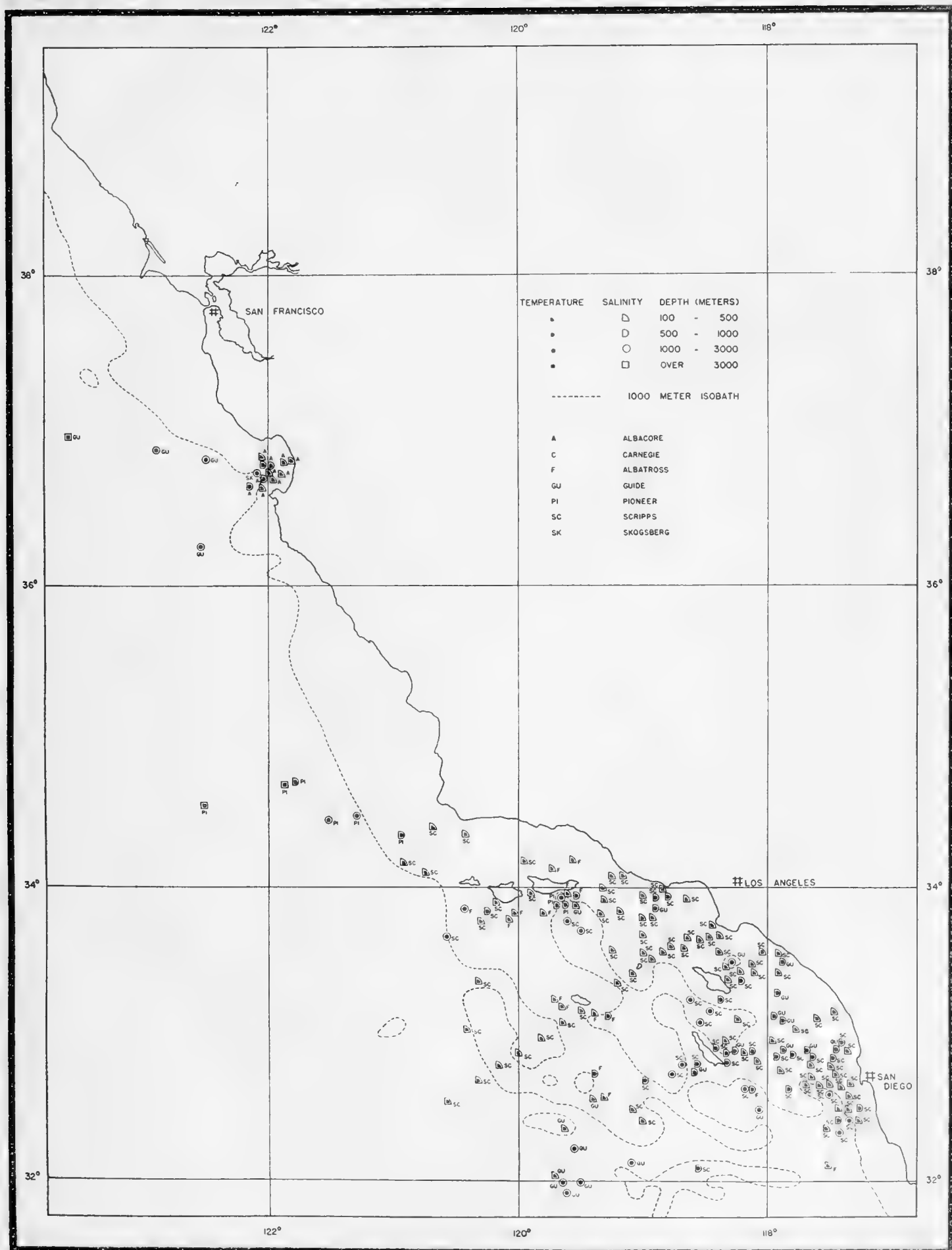


B. GULF OF ALASKA TO SAN FRANCISCO, SERIAL SECTIONS OF TEMPERATURE AND SALINITY



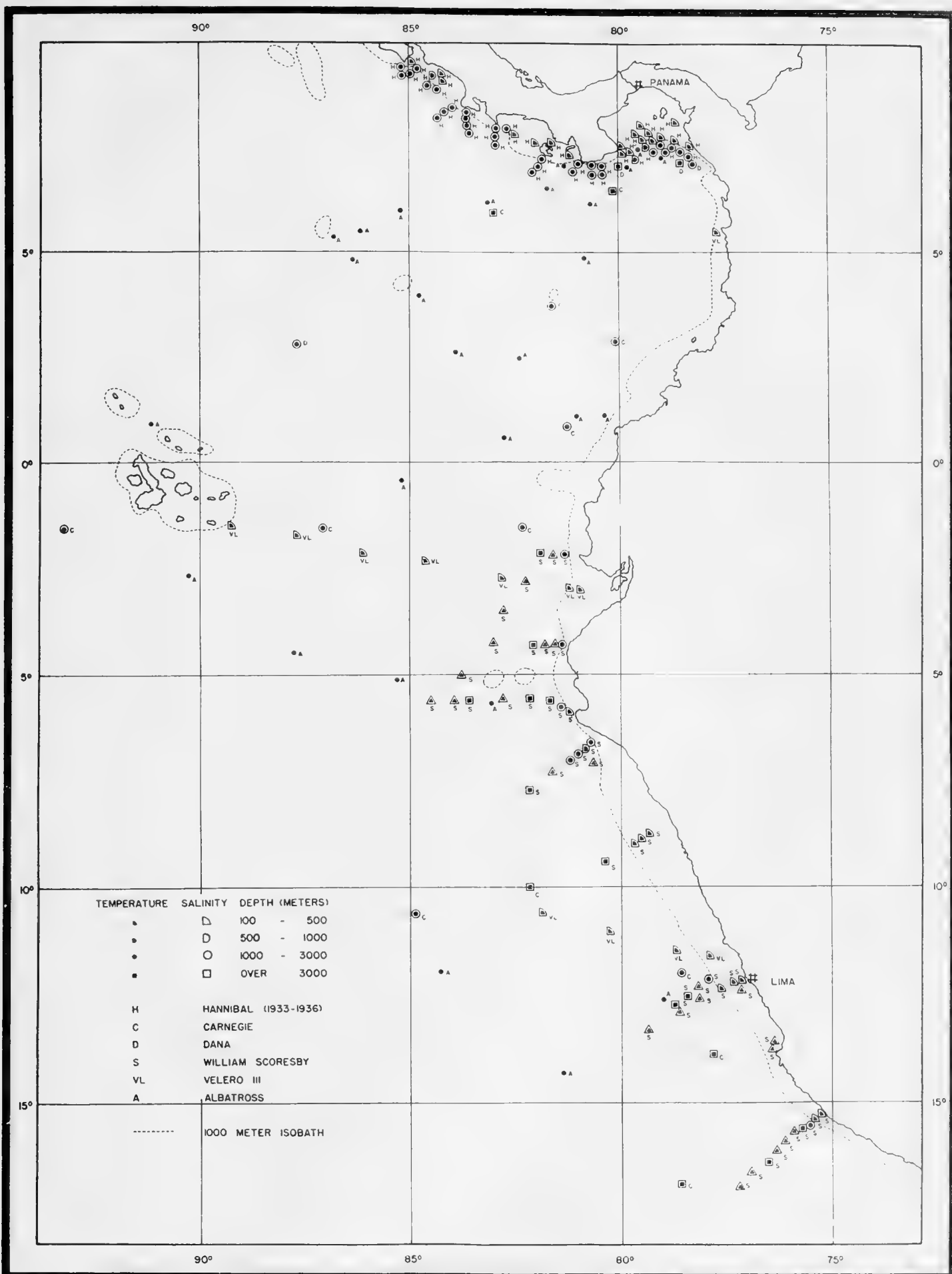
THESE ARE THE RESULTS OF THE ANALYSIS OF THE SAMPLES OF THE SUBSTANCE.





OFF COAST OF SOUTHERN CALIFORNIA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

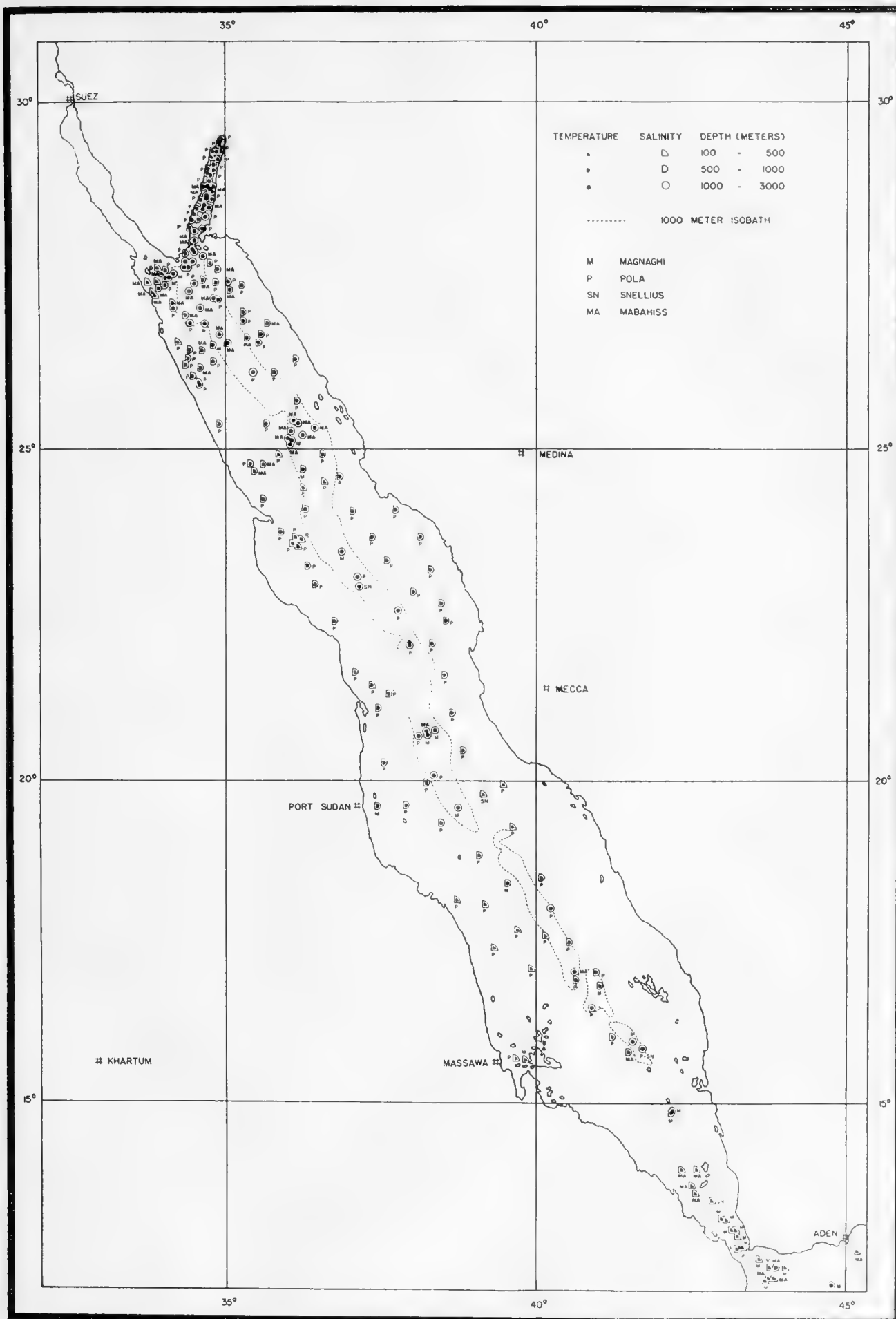




OFF COASTS OF COSTA RICA, PANAMA, AND NORTHERN SOUTH AMERICA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

The triangular symbol signifies, depths not available





RED SEA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY



# RED SEA AND INDIAN OCEAN

## RED SEA, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

PLATE 17

The sources of the data for the Red Sea plotted on the chart are as follows: (The letters after the ships' names are the abbreviations used on the chart.)

### SOURCES OF DATA

MABAHISS (MA): Station list pp. 3-29, 1 chart. John Murray Expedition to the Indian Ocean 1933-34. Under the leadership of Lt. Col. R. B. Seymour Sewell, C.I.E., F.R.S. Stations A, 1-11, 203-209, M. B. I. in the Red Sea. Manuscript list from Dr. C. Crossland for stations occupied in 1934 and 1935.

MAGNAGHI (M): Picotti, Mario, *Ricerche de Oceanografia Chimica*, Part I—Tabelle generali della analisi clorometriche e dei di temperatura, salinità e densità: Inst. Idrograf. della Reg. Marina., Ann. Idrograf., vol. 11 Bis, no. 3048, pp. 1-47, 1927.

POLA (P): Koss, Karl, *Expedition S. M. Schiff POLA in das Rothe Meer: Berichte der Commission für Oceanographische Forschungen*, 6 Reihe 1895-1896, pp. 1-572, 1898, and 7 Reihe, pp. 1-485, 1897-1898, 1901.

WILLEBRORD SNELLIUS (SN): van Riel, P. M., *Einige ozeanographische Beobachtungen im Roten Meer, Golf von Aden, und Indischen Ozean*: Ann. Hydrogr. und marit. Meteorol., 60 Jahrg. (1932), Heft 10, pp. 401-407, 1932.

## INDIAN OCEAN, SERIAL SECTIONS OF TEMPERATURE AND SALINITY

PLATE 18

As the base chart of this compilation there was used Defant's chart entitled, "Hydrographische Reihenmessungen seit 1870 im Indischen Ozean."<sup>1</sup> The indicated data have been used by Lotte Möller in her paper cited in the footnote.<sup>2</sup> After the data obtained by the DANA were in condition for use Helge Thomsen published the paper cited below,<sup>3</sup> and it was followed by a discussion by Lotte Möller.<sup>4</sup> Because of the additional data procured by the DANA, Thomsen thought Möller's interpretation of the deep-water circulation of the Indian Ocean required modification. He questioned the existence of a southward moving current between depths of 2,000 and 3,000 meters. In 1932 Lt. Col. R. B. Seymour Sewell's "Geographic and oceanographic

research in Indian waters"<sup>5</sup> was published. It marked a distinct advance in knowledge of the oceanography of the northern part of the Indian Ocean, and served as a basis of a discussion by G. Wüst<sup>6</sup> of the origin of the bottom water of the Indian Ocean as inferred from potential temperatures.

In 1933-34 there was an important expedition to the Indian Ocean on His Egyptian Majesty's ship MABAHISS under the leadership of Lt. Col. R. B. Seymour Sewell. This was the first expedition the expenses of which were defrayed from a fund set aside from the estate of the late Sir John Murray. Therefore the expedition is called the John Murray Expedition to the Indian Ocean. The reports giving the results of the expedition are now being published by the British Museum (Natural History). The station list of the expedition has just appeared in print.

Professor Defant plotted on the chart published by him the data available in the Institut für Meereskunde up to February 1, 1928. The sources of his data for the Indian Ocean are as follows:

<sup>1</sup> Defant, A., *Die systematische Erforschung des Weltmeeres: Zeitsch. der Gesellsch. für Erdkunde zu Berlin, Jubiläums-Sonderband*, 1928.

<sup>2</sup> Möller, Lotte, *Die zirkulation der Indischen Ozeans: Inst. Meeresk. Berlin, Veröffentl. N. F., A. Geograph.-naturwissensch. Reihe, Heft 21*, pp. 1-48, 24 Abbild. im Text, April, 1929.

<sup>3</sup> Thomsen, Helge, *The circulation in the depths of the Indian Ocean: Cons. Internat. Expl. Mer., Jour.*, vol. 8, pp. 73-39, 1933.

<sup>4</sup> Möller, Lotte, *Zur Frage der Tiefenzirkulation im Indischen Ozean: Ann. d. Hydr. usw. 1933, Heft 7-9*, pp. 233-236, pls. 29, 29a.

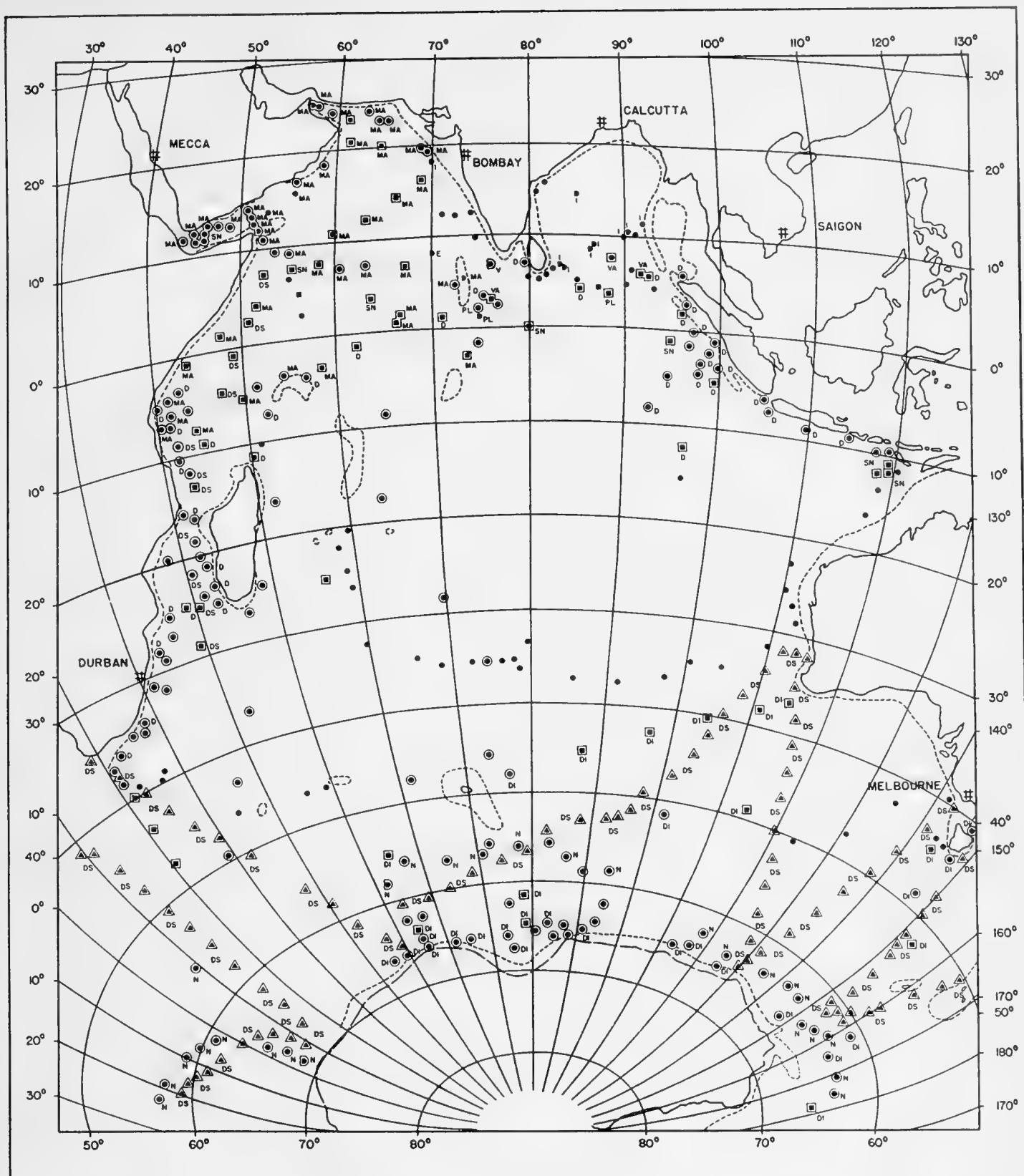
<sup>5</sup> Asiatic Soc. of Bengal, *Mem.*, vol. 9, 1932.

<sup>6</sup> Wüst, G., *Anzeichen von Beziehungen zwischen Bodenstrom und Relief in der Tiefsee des Indischen Ozeans: Die Naturwissensch. 1934, Jahrg. 22, Hft. 16*, pp. 241-244, 1934.

## SOURCES OF DATA FOR THE INDIAN OCEAN

*After A. Defant*

NAME OF SHIP	TIME OF WORK	POSITION OF STATIONS	SOURCE OF DATA
CHALLENGER	December 1873 March 1874	45–46°S, 34–48°E 42–50°S, 123–134°E	Report on the scientific Results of the voyage of H. M. S. CHALLENGER during the years 1873–1876, Physics and Chemistry, vol. 1, London 1884, pls. 93–95, 98–100.
GAZELLE	March 1875 April 1875 May 1875	22–36°S, 58–72°E 28–36°S, 76–122°E 8–16°S, 117–124°E	Forschungsreise S. M. S. GAZELLE, Hrsg. vom Reichsmarineamt. Physik und Chemie, vol. 2, Berlin 1888/89, p. 40.
ELISABETH	9, January 1877	39°S, 26°E	Kapitän z. S. Wickede, Tiefseebeobachtungen S. M. S. ELISABETH, Annalen der Hydrographie, 1878, p. 319.
INVESTIGATOR	October 1887	6–10°N, 90–91°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths, 1888, London 1889, pp. 8, 9.
PENGUIN	April 1891	22–27°S, 110–111°E	Ibid., 1891, London 1892, p. 10, 11.
INVESTIGATOR	April 1892 October 1892 & 1893	9–15°N, 74–81°E 12°N, 70–73°E	Ibid., 1892, London 1893, pp. 10, 11 und 1893, London 1894, pp. 10, 11.
WATERWITCH	January 1895	39°S, 23–27°E	Ibid., 1895, London 1896, p. 20.
STORK	April/May 1897	2–6°N, 55–56°E	Ibid., 1897, London 1898, pp. 50, 51.
VALDIVIA	January 1898 December 1898 January 1899 February 1899 March/April 1899	34°34'S, 25°54'E 56–62°S, 14–59°E 36–15°S, 78–96°E 7°N–1°S, 76–96°E 9°N–5°S, 43–53°E	G. Schott, Ozeanographie und maritime Meteorologie. Wiss. Ergebnisse der Deutschen Tiefsee-Expedition 1898/99, vol. 1, Jena 1902, Text figs., pls., 18, 20–22, 24–26.
GAUSS	Dec. 1901–May 1903	Südwestindischer Ozean, Subantarktisches Gebiet	E. v. Drygalski, Ozean und Antarktis, Meereskundliche Forschungen und Ergebnisse der Deutschen Südpolar-Expedition 1901–1903, vol. 7, Berlin 1925, pp. 476–483.
SEALARK	29, September 1905	10°S, 51°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1905, London 1906, pp. 30, 31.
PLANET	April 1906 May 1906 June 1906	49°31'S, 29°16'N	Die Forschungsreise S. M. S. PLANET, hrsg. vom Reichsmarineamt, vol. 3, Berlin 1909, pp. 57–59.
SEALARK	April–May 1909	5–6°N, 80–82°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1909, London 1910, p. 24.
MöWE	January/February 1913	Route: Kapstadt, Durban, Beira, Lindi	Ozeanogr. Arbeiten S. M. S. MöWE im westlichen Indischen Ozean 1913, Annalen der Hydrographie 1915, p. 341.
MERLIN	November 1920	4°N, 85–93°E	Hydrogr. Department of the Admiralty, List of Oceanic Depths 1920, London 1921, p. 23.
AMMIRAGLIO MAGNAGHI	April 1924	11°55'N, 45°50'E	Campagna idrografica nel Mar Rosso della R. N. AMMIRAGLIO MAGNAGHI 1923/24, Ricerche di oceanografia fisica, Part 4, Annali Idrografici 1926.
ORMONDE	April/Mai 1927	12–13°N, 44–47°E	D. J. Matthews, Temperature and Salinity Observations in the Gulf of Aden, Nature 1927, London 1927, p. 512.



## SYMBOLS

TEMPERATURE	SALINITY	DEPTH (METERS)
●	D	500-1000
○	O	1000-3000
■	□	> 3000
▲	△	NOT AVAILABLE

## INDIAN OCEAN, GENERAL CHART

Serial Sections of Temperature and Salinity. Stations without abbreviations taken from Defant, prior to February 1, 1928; stations with abbreviations added to Defant's charts, mostly subsequent to February 1, 1928.



SUPPLEMENTAL SOURCES OF DATA FOR THE  
INDIAN OCEAN

The positions of the stations plotted by Defant are without abbreviations. There are added with abbreviations the positions of other stations, mostly of dates subsequent to February 1, 1928. A list of the sources of the data is as follows: (The letters after the ships' names are the abbreviations used on the chart.)

DANA (D): List of Stations, DANA Report No. 1, pp. 17-78, seven plates, 1934. Stations 3804-3809, 3812-3973, pp. 45-60. (The Carlsberg Foundation's Oceanographical Expedition Round the World 1928-1930, and previous DANA Expeditions, under the leadership of Prof. Johannes Schmidt.)

DISCOVERY I (DI): Manuscript data from Sir Douglas Mawson. Reports in press.

DISCOVERY II and WILLIAM SCORESBY (DS): Manuscript data from Dr. Stanley Kamp.

MABAHISS (MA): Station list pp. 3-29, 1 chart: John Murray Expedition to the Indian Ocean 1933-34. Under the leadership of Lt. Col. R. B. Seymour Sewell, C.I.E., F.R.S. Stations 12-202 in the Indian Ocean.

EGERIA, INVESTIGATOR, PLANET, VALDIVIA, and VITIAZ (E) (I) (PL) (VA) (V): Sewell, R. B. Seymour, Geographic and Oceanographic Research in Indian Waters: Asiatic Society of Bengal, Memoirs, vol. 9, no. 6, pp. 357-424, 1932.

WILLEBRORD SNELLIUS (SN): van Riel, P. M., Einige Ozeanographische Beobachtungen im Roten Meer, Golf von Aden, und Indischen Ozean: Ann. Hydrog. u. marit. Meteorol., vol. 60, Jahrg. 1932, Heft 10, pp. 401-407, 1932.



## **CHARTING THE BOTTOM OF THE OCEANS**



# SOUNDED AND UNSOUNDED AREAS

PLATES 19, 20, 21, 22, 23

The accompanying charts showing the sounded and unsounded areas of sea bottom are based upon charts prepared by the United States Hydrographic Office. Several years ago that office published five charts, one each for the north and south Atlantic, one each for the north and south Pacific, and one for the Indian Ocean, on which were shown the sounded and unsounded areas in the three oceans. These charts were intended to guide United States Naval vessels, equipped with sonic-sounding apparatus, in complying with instructions that when practicable their courses be laid across unsounded areas, so as gradually to complete surveys of the ocean bottom for bottom configuration. The supplemental information, much of it not yet published, that had been assembled in connection with this report has been added to the charts already drawn. It is hoped that these charts represent with fair accuracy what has been done in ascertaining the configuration of the sea bottom, and that they may serve to guide vessels of other countries, as well as those of the United States, to those areas on which there is inadequate information.

It is pertinent here to refer to the article. "The bathymetric soundings of the oceans," by Lt. Com. H. Bencker, published by the International Hydrographic Bureau, June 1930, and presented at the meeting in Stockholm of the Section of Physical Oceanography, International Union of Geodesy and Geophysics, August 1930. This paper, in addition to a general account of the growth of knowledge of the bathymetry of the oceans, contains five appendices, one of which is "Chronological list of *oceanic explorations* from the year 1800," and another is "List arranged by oceans, of *principal oceanic deeps*."

Mention may be made of converting the sound intervals of echo soundings into true depths. Data on subsurface temperatures and salinities in the oceans are now becoming so extensive that the time is ripe for a revised edition of the British Admiralty's "Tables of the velocity of sound in pure water and sea water for use in echo-sounding and sound-ranging," published in 1927. Those institutions that

have acquired pertinent data would render meritorious service to oceanography by cooperating with the British Admiralty in perfecting that valuable publication. It should be practicable to deduce almost instantaneously the true depth from the echo time-interval.

A glance at the accompanying charts shows that for the more general features the north Atlantic and the north Pacific have been mostly, but not entirely, covered. Recently, largely because of the activities of the METEOR and DISCOVERY II, knowledge of the south Atlantic has been greatly increased, but the lines of soundings north of latitude 50°S. are still so far apart that only the outlines of the grosser features may be surely recognized. Exploration of Antarctic waters has been intensely prosecuted since 1925 by the DISCOVERY II and WILLIAM SCORESBY, and, beginning somewhat later, by DISCOVERY I and NORWEGIA. So many additional lines have been run that it should now be possible to construct a new bathymetric chart for the seas around Antarctica, south of about 50°S. latitude. There are also lines from Antarctica to southern Africa, southern Australia, New Zealand, and southern South America. The MABAHIS has recently, 1933, greatly added to knowledge of the northwestern Indian Ocean, as shown in an article by Wiseman and Sewell.<sup>1</sup> Other important recent work on the bathymetry of the Pacific comprises new bathymetric charts of the South China Sea by the Institut Océanographique de l'Indochine, of the seas adjacent to Japan by the Hydrographic Department of Imperial Japanese Navy, of Philippine waters by the Philippine Coast and Geodetic Survey, and of the Netherlands East Indies by the SNELLIUS Expedition. The last mentioned charts constitute one of the finest publications on bottom topography ever issued.<sup>2</sup> Plate 1, composed of two sheets, is a colored bathymetric chart of the eastern part of the

<sup>1</sup> Wiseman, J. H. D., and Sewell, R. B. S., The floor of the Arabian Sea: Geolog. Mag., vol. 74, pp. 219-230, pl. 11, May, 1937.

<sup>2</sup> van Riel, P. M., Bottom configuration in relation to the flow of the bottom water: SNELLIUS Expedition, vol. 2, Oceanographic Results, part 2, chapter 2, pp. 63, 6 pls., 16 detailed charts, 1934.

East Indian Archipelago on a scale of 1:2,500,000. Plate 2 is a colored bathymetric chart of the East Indian Archipelago on a scale of 1:5,000,000. It is also gratifying to record that the International Hydrographic Bureau is publishing a revised edition of the *Carte bathymétrique générale des Océans*.

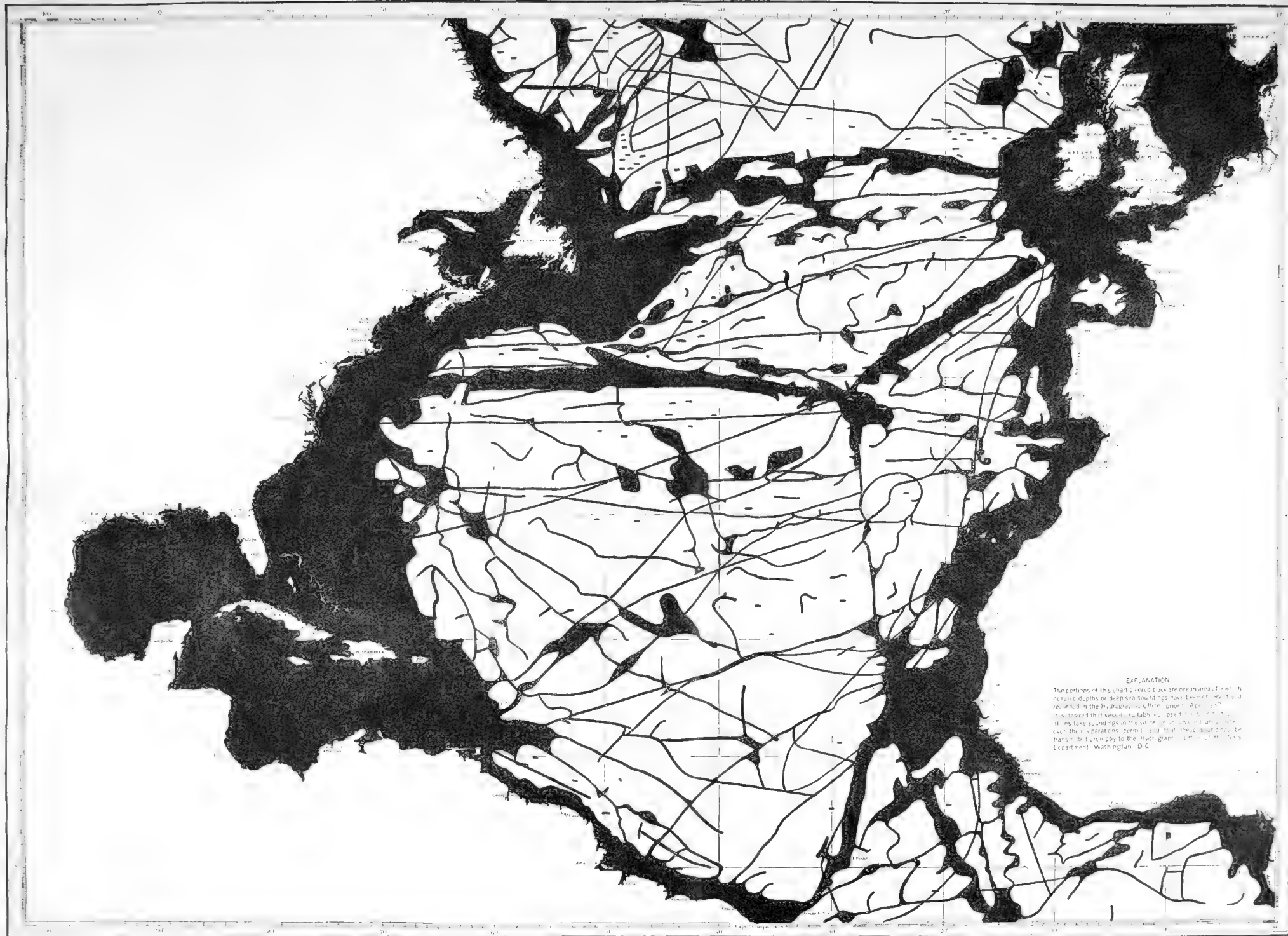
The foregoing few notes on recent progress in the study of sea-bottom configuration are gratifying, but there are still two enormous areas of sea bottom on which only a little information is available. These are most of the Pacific Ocean, except near its shores, between the Equator and 50°S. latitude, and, except adjacent to Antarctica, most of the Indian Ocean east of longitude 70°E. and south of latitude 10°S. There are other areas on which information is inadequate, such as that between the Hawaiian Islands and the American coast, but the two above indicated are the most outstanding large areas on which there is little or no information.

The remarks so far made apply to the larger features of bottom configuration, but before leaving the subject some consideration should be given to the more minute features of relief. It would require considerable searching of literature to discover who

was the first to recognize that there are on the ocean floor earth-forms that are trench-like, others that are precipitous and simulate fault-scarps, et cetera, but we do know that the invention of radio-acoustic position-finding and the invention of echo-sounding devices has made possible the recognition of minutiae of sea-bottom configuration that was entirely impossible only a few years ago. While in sight of land, by making closely spaced line-soundings it is possible to develop the side walls and floor of a trench, as Shepard has done,<sup>3</sup> but when farther out at sea other methods of successive place-finding are essential. It has now been convincingly shown that the continental shelf off the east coast of the United States is incised by numerous trenches which can be traced to depths of 1,800 meters or more.<sup>4</sup> The origin of these features is one of the great enigmas of geology and oceanography. They are mentioned here in the hope that research on them may be extended to other parts of the world.

<sup>3</sup> Shepard, F. P., Continued exploration of California submarine canyons: Amer. Geophys. Union, meeting 1936, Trans. pp. 221-223, 1936.

<sup>4</sup> Smith, Paul A., Submarine valleys: U. S. Coast and Geodetic Surv. Field Engineers Bull. No. 10, pp. 150-158, Dec. 1936.



## EXPLANATION

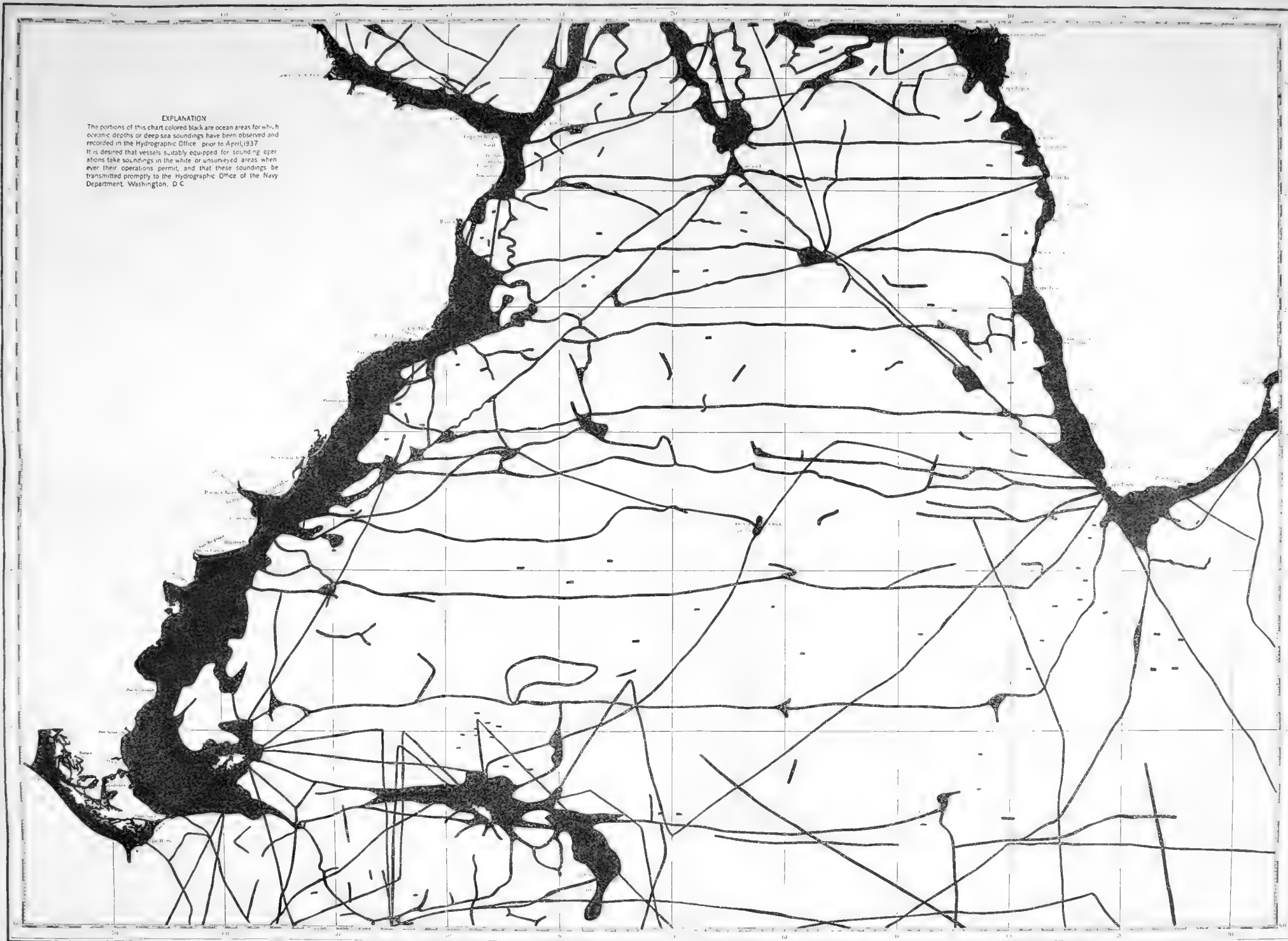
The portions of this chart covered by black are ocean areas for which ocean depths or deep sea soundings have been received by the Hydrographic Office prior to April 1, 1900. It is assumed that vessels suitably equipped for the purpose of making soundings and depths in the unblack areas are authorized to do so, and that these soundings may be furnished to the Hydrographic Office of the Navy Department, Washington, D.C.



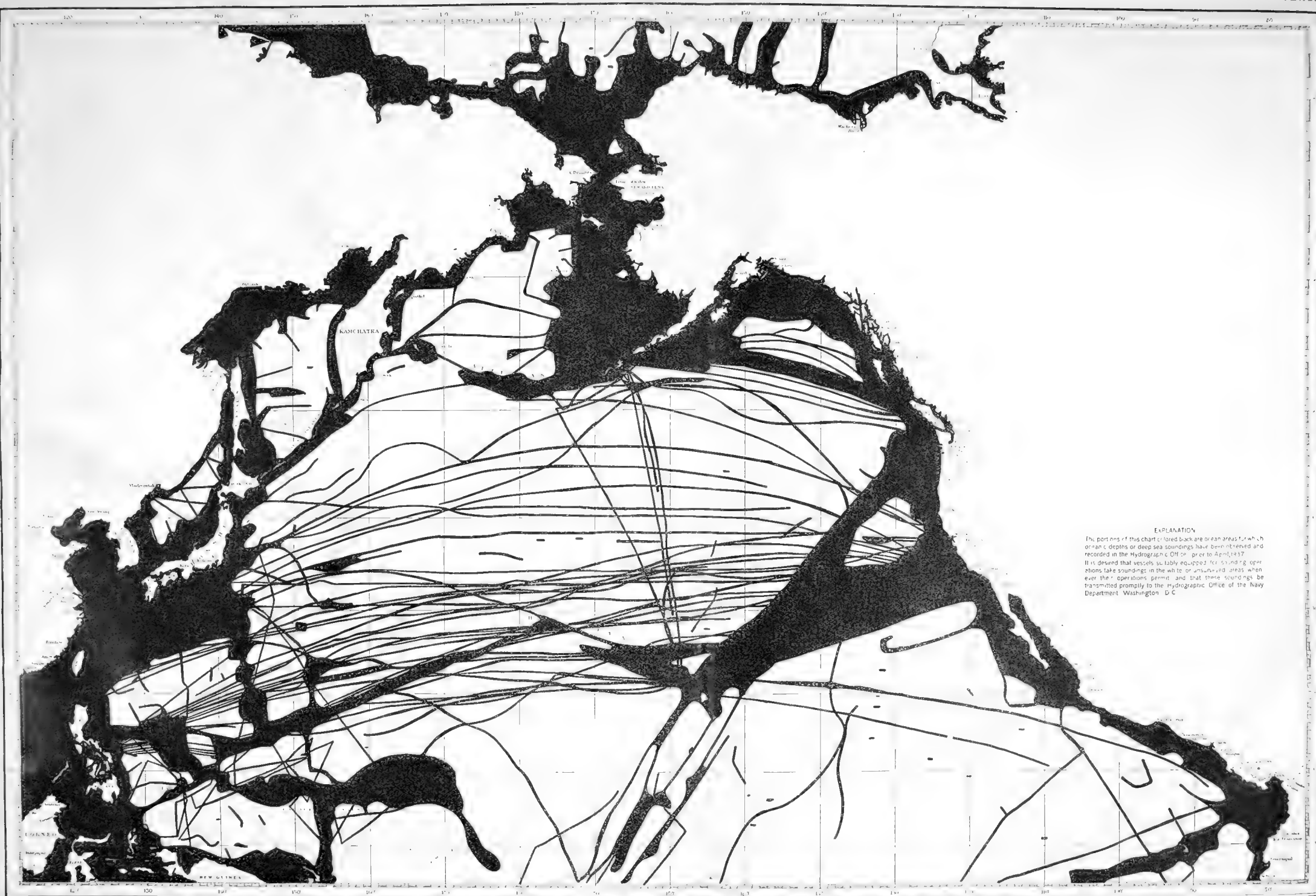
SOUTH ATLANTIC OCEAN  
INDEX CHART OF UNSOUNDED AREAS

## EXPLANATION

The portions of this chart colored black are ocean areas for which oceanic depths or deep sea soundings have been observed and recorded in the Hydrographic Office prior to April, 1937. It is desired that vessels suitably equipped for sounding operations take soundings in the white or unsounded areas, when ever their operations permit, and that these soundings be transmitted promptly to the Hydrographic Office of the Navy Department, Washington, D. C.

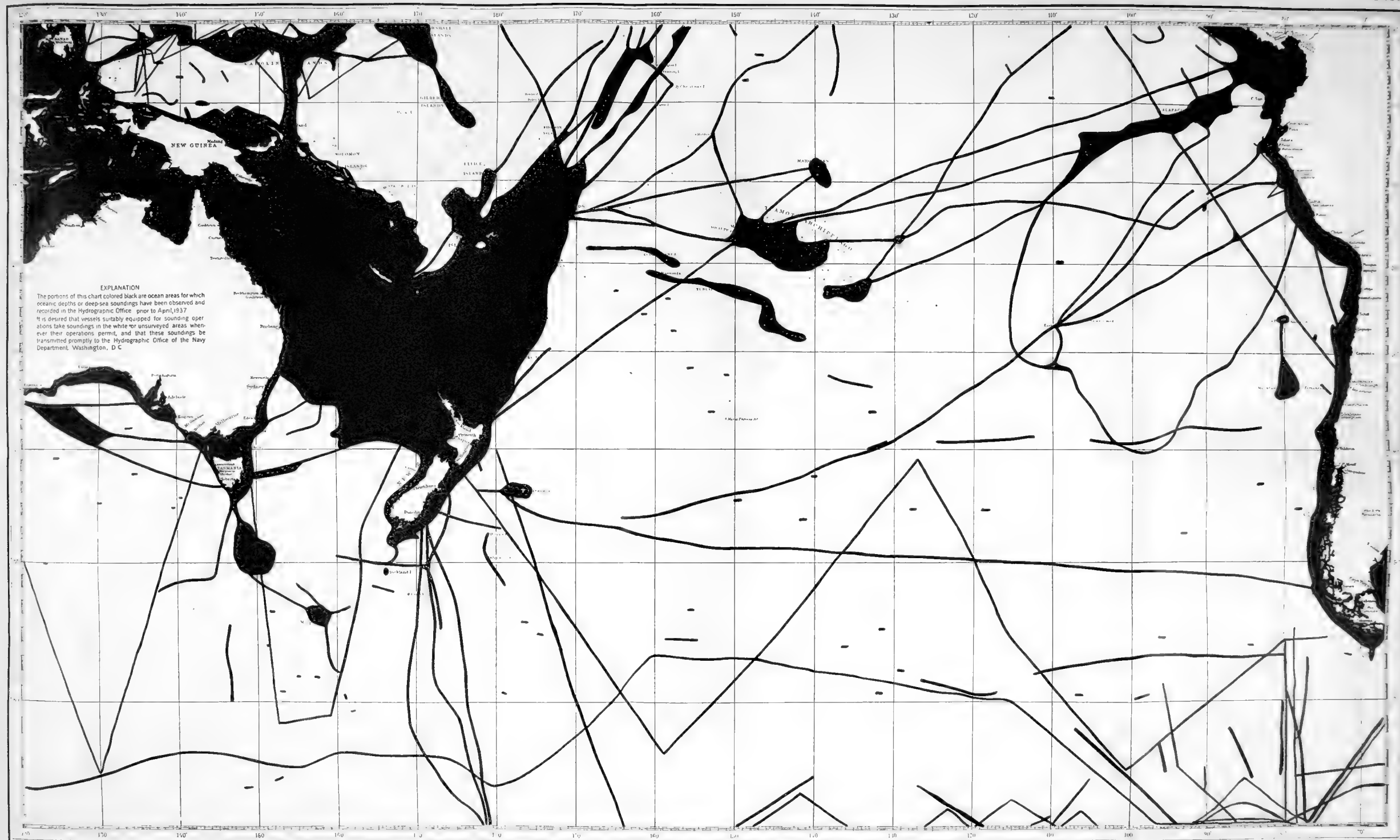




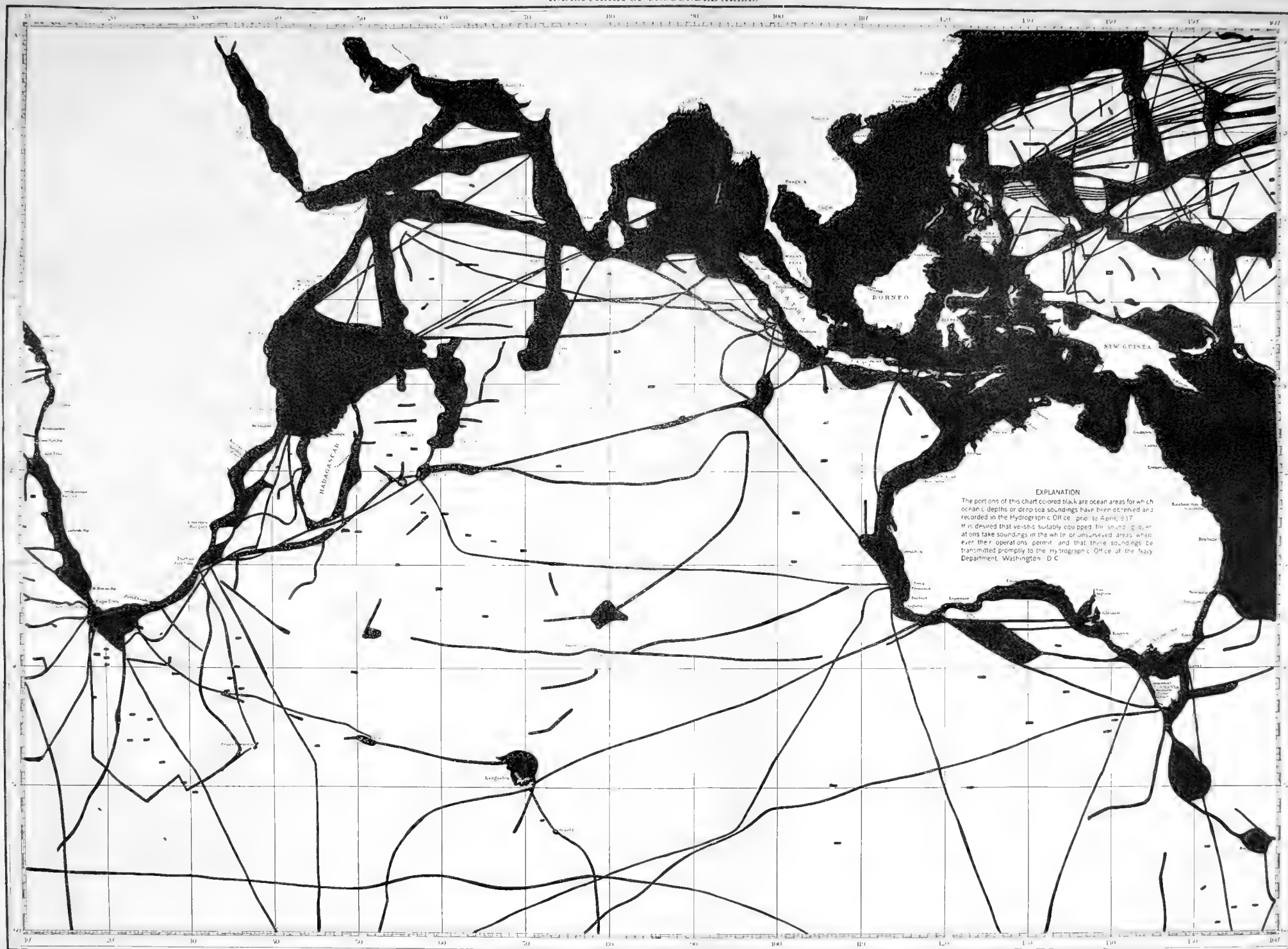




# SOUTH PACIFIC OCEAN INDEX CHART OF UNSOUNDED AREAS









# MARINE BOTTOM DEPOSITS

No general review of the subject of marine bottom deposits will be attempted here but a sufficient number of references to literature will be given to show the present status of mapping the material on the sea-floor. Nearly all, if not all, modern research expeditions have systematically collected samples of the sea bottom, and reports on the material obtained have either been written or are in preparation. Since the later reports utilize the information contained in the earlier publications, it is necessary to mention only recent reports. Although the material collected by modern expeditions has been or is being utilized, it must be recognized with regret that there are enormous collections of marine bottom samples procured by earlier expeditions that have not been critically studied—for example, there are thousands of such samples in the United States National Museum awaiting study. There have been far too few students of marine bottom deposits. The only large museum that has on its staff a member whose major duty is to study marine bottom samples is the British Museum of Natural History. Several of the oceanographic institutions have specialists on the subject attached to their staffs, but the researches of most of the investigators are incidental to other activities.

For the Atlantic Ocean the most comprehensive reports are those on the results of the METEOR Expedition. Two of them, by Correns and his associates<sup>1</sup> have been published. The study of the samples obtained in the south Atlantic was entrusted to O. Pratje, who has published one *Lieferung* on his results,<sup>2</sup> and it is understood that another part will follow. Until now no chart presenting the results for the entire Atlantic has appeared.

Three reports on collections made by the DIS-

COVERY II and WILLIAM SCORESBY have appeared.<sup>3</sup> Two papers by Thorp are cited in a footnote.<sup>4</sup> The second paper by Thorp is concerned with only shallow-water deposits of the kind indicated in the title. It contains references to all important literature on the subject, for both the Atlantic and Pacific Oceans.

For the Pacific and Indian Oceans, W. Schott<sup>5</sup> has given a comprehensive review, accompanied by a bibliography, of the subject up to the end of 1934. Thorp, in the short paper cited below,<sup>6</sup> describes the shallow-water calcium-carbonate deposits of another area in the Pacific. Of the DISCOVERY Reports already published only the one Neaverson, already noted, deals with Pacific sediments. An extensive report by Roger Revelle on the bottom samples collected in the Pacific by the CARNEGIE is now in press as a publication of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. P. H. Kuenen has in preparation a report on the marine bottom samples collected by the WILLEBRORD SNELLIUS in the Netherlands East Indies. The specimens collected by the MABAHISS are being studied by J. D. H. Wiseman, who has published an interesting article on volcanic rock dredged from the bottom off Providence Island<sup>7</sup> and the paper by him and R. B. S. Sewell, "The floor of the Arabian Sea," already cited, con-

<sup>3</sup> Matthews, L. Harrison, The marine deposits of the Patagonian continental shelf: DISCOVERY Reports, vol. 9, pp. 175-206, pls. 2-14, 1934.

Moore, Hilary B., Faecal pellets from marine deposits: DISCOVERY Reports, vol. 7, pp. 17-26, 1 text-fig., 1933.

Neaverson, E., Sea-floor deposits, I. General characters and distribution: DISCOVERY Reports, vol. 9, pp. 295-350, pls. 17-22, 1934.

<sup>4</sup> Thorp, E. M., Descriptions of deep-sea bottom samples from the western north Atlantic and the Caribbean Sea: Scripps Inst. Oceanogr. Tech. Bull., vol. 3, pp. 1-31, 5 text-figs., 1 chart, 1931.

Thorp, E. M., Calcareous shallow-water marine deposits of Florida and the Bahamas: Carnegie Inst. Washington Pub. no. 452, pp. 37-143, 14 text-figs., 5 pls., Dec. 1935.

<sup>5</sup> Schott, W., Die Bodenbedeckung des Indischen und Stillen Ozeans: in G. Schott's Geographie des Indischen und Stillen Ozeans, pp. 109-122, pl. 5, 1935.

<sup>6</sup> Thorp, E. M., The sediments of the Pearl and Hermes Reed (Midway Islands): Jour. Sed. Petrol., vol. 6, pp. 109-118, 1 fig., 1936.

<sup>7</sup> Wiseman, J. D. H., The petrography and significance of a rock dredged from a depth of 744 fathoms, near to Providence Reef, Indian Ocean. Linn. Soc. Zool. Trans. ser. 2, vol. 19, pp. 437-443, 3 text-figs., 1936.

<sup>1</sup> Correns, Carl W., A. Die Verfahren der Gewinnung und Untersuchung der Sedimente: Die Sedimente des äquatorialen Atlantischen Ozeans, Wissensch. Ergeb. METEOR, vol. 3, 3d pt., 1st Lief., pp. 42, 1935.

Schott, W. B., Die Foraminiferen in dem äquatorialen Teil des Atlantischen Ozeans: *Ibid.*, 1st Lief., pp. 43-134, 3 Beilagen, pls. 1, 2, 1935.

Correns, Carl W., C. Zusammenstellung der Untersuchungsergebnisse nach Stationen geordnet; D. Auswertung der Ergebnisse, mit Beiträgen von V. Leinz und O. E. Radezewski: *Ibid.*, 2d Lief., pp. XII, 135-298, pls. 3, 4, 1937.

<sup>2</sup> Pratje, O., Gewinnung und Bearbeitung der Bodenproben: Die Sedimente des Südatlantischen Ozeans, Wissensch. Ergeb. METEOR, vol. 3, pt. 2, 1 Lief., 1935.

tains information on material on the bottom of the Indian Ocean. Basaltic lava, dredged at two places, is noteworthy because of its low radium-content.

The relative exploration of the sea-bottom for material composing it is only approximately indicated by the distribution of stations for serial sections of temperature and salinity, for numerous bottom samples have been collected at places for which information on the physical features of the water is lacking or inaccurate. There are large areas in the Pacific and Indian Oceans, the same areas for which other information is deficient, from which few or no collections of bottom material have been made.

During recent years there have been great changes in the methods of studying marine sediments due to the application of the principles of physical chemistry to numerous problems of the sediments themselves and to problems of the seawater associated with the sediments and due to the utilization of X-ray analysis. It is not necessary to discuss the methods of this later work for they are described in connection with the reports on the samples collected by the METEOR, CARNEGIE, and other research vessels, and in other papers on marine sediments. It is pertinent to call attention here to a volume "Symposium on Recent Sediments" now in preparation by the Committee on Sedimentation of the United States National Research Council, under the editorship of Parker D. Trask. Many specialists are coöperating in the work.

Another development of significance is the improvement of the older, and the invention of new devices for obtaining cores of the sea bottom. There have been numerous modifications of Ekman's bottom sampler, which depends upon a weight to drive a tube into the bottom. One helpful modification is that of Trask.<sup>8</sup> A commendable feature of Trask's design is its cheapness, the cost need not exceed about five dollars. Another valuable device is that of Kuenen.<sup>9</sup>

The most noteworthy advance in the design of coring devices is that of Piggot.<sup>10</sup> The power to

drive the tube into the bottom is derived from an explosive, that is the upper part of the apparatus is a gun. The numerous cores, up to ten feet long that have been taken, retain the stratification of the material sampled and make possible a study of the stratigraphy of the bottom material. It may be confidently expected that the Piggot gun will come into general use for sampling sea-bottom material, and that those samplers that take material only from the surface of the bottom will be replaced. Provisions for operating the Piggot gun have been made on the research vessels of both the Woods Hole Oceanographic Institution and the Scripps Institution of Oceanography. It is probable that similar arrangements will be made on other vessels.

The incentive that led Doctor Piggot to invent his gun was to procure core-samples for the study of the radium-content of marine bottom-deposits. He determined the amounts of radium in a series of samples collected by the CARNEGIE by means of a snapper-type of sampler. The results were not altogether satisfying—cores were needed. He has kindly prepared the following summary statement for this report.

*Radium Content of Marine Bottom Deposits*, by C. S. Piggot, Geophysical Laboratory, Carnegie Institution of Washington.

Though many determinations have been made of the radium content of various rocks from many localities on the continental surfaces of the earth, very few such measurements have been made on the materials comprising the ocean-bottom sediments. The reasons for this are obvious, but when the vast area covered by these sediments is considered, and especially their high radium content, it is apparent that they may have a geophysical significance of very great importance.

The meagerness of the available data is emphasized when it is pointed out that only some sixty-eight determinations have been published, of which Joly published twelve in 1908,<sup>11</sup> Hans Pettersson twenty-eight in 1930,<sup>12</sup> and Piggot twenty-eight in 1932<sup>13</sup>, and these represent a material covering nearly three-fourths of the surface of the earth. Furthermore, these sediments are of unknown thickness, and as there is little likelihood that direct measurements of the thickness will ever be made, a knowledge of

<sup>8</sup> Trask, Parker D., Oceanography and oil deposits: Amer. Geophys. Union, Trans., Nat. Res. Council Bull. no. 61, pp. 235-242, 1927.

Trask, Parker D., Origin and environment of source sediments of petroleum: Gulf Pub. Co., Houston, Tex., 1932. See p. 12, fig. 1, C.

<sup>9</sup> Kuenen, Ph. H., Die Viermeter-Lotröhre der SNEELIUS Expedition: Ann. d. Hydrogr. u. marit. Meteorologie, March, 1932.

<sup>10</sup> Piggot, C. S., Apparatus to secure core samples from the ocean bottom: Geol. Soc. Amer. Bull., vol. 47, pp. 675-684, 3 pls., 1 fig., 1936.

<sup>11</sup> Joly, J., Phil. Mag., vol. 16, p. 190, 1908.

<sup>12</sup> Pettersson, Hans, Teneur en radium des dépôts de mer profonde: Résultats de Campagnes Scientifiques par Albert 1<sup>er</sup> Prince Souverain de Monaco, fascicule 81, 1930.

<sup>13</sup> Piggot, C. S., Radium content of ocean-bottom sediments: Amer. Jour. of Sci., vol. 25, pp. 229-238, March, 1933.

this factor can be got only by a study of the rate of deposition. The most promising method for accomplishing this is one based upon radioactive considerations. Therefore, a study of ocean bottom sediments from this point of view is of the greatest importance in securing fundamental information about these vast deposits.

The radium content of the granitic rocks of the earth varies from about  $1-3 \times 10^{-12}$  grams of radium per gram of rock; and of the basaltic rocks about 1 on the same scale. The sedimentary rocks average less than the basalts, whereas the ocean bottom sediments are found to contain several times as much as even the granites. The average for Joly's twelve determinations is  $17.8 \times 10^{-12}$  grams Ra per gram of sample, which is considered to be rather high. Pettersson's twenty-eight determinations average  $10.96 \times 10^{-12}$  grams/gram, with a maximum of  $49.5 \times 10^{-12}$  grams/gram. Piggot's results average  $6.52 \times 10^{-12}$  grams/gram with  $21.40 \times 10^{-12}$  grams/gram as the greatest.

These high concentrations of radium are the more remarkable when one considers that the uranium represented by this radium must come originally from the igneous rocks. Apparently it did not concentrate to any great extent in the sedimentary rocks at the time of their formation presumably in shallow seas but has concentrated to a considerable extent in those sediments which are now accumulating slowly in the deeper and more remote portions of the ocean.

Usually the red clays contain a higher concentration of radium than do the other deposits. Of the samples examined by Pettersson and Piggot whose characters are definitely known, 27 red clays average  $12.1 \times 10^{-12}$  grams Ra per gram, and 13 Globigerina oozes average  $4.1 \times 10^{-12}$  grams Ra per gram of sample.

Joly suggested that the minute organisms of the sea abstract uranium, more or less selectively, from the water and when they die their skeletons carry it to the bottom with them. However, the higher

radium concentrations are not found associated with any of the various skeletal deposits.

Pettersson found high radium concentration associated with evidences of volcanic activity and he suggests that the unusual concentrations are brought about by submarine volcanism. Pettersson's explanation seems rather specialized to be of general application.

Piggot points out that the oxides of uranium like those of iron and manganese are among the least soluble of its compounds and that it is in those portions of the ocean bottom, in general, where the oxides of manganese and iron are separated, as revealed by the nodules of these elements, that the uranium concentration as revealed by the radium content is the higher. This accords with the observations of the oxygen content with depth made by the *CARNEGIE*, which revealed that though the oxygen content fell off very rapidly down to about 1000 fathoms, it increased from then on and soon attained a magnitude about two-thirds of that at the surface. Therefore the deep, undisturbed areas, far from land and detrital debris, furnish an oxidizing environment where the uranium separates out, and appears in the highest concentrations at those places of slowest sedimentation.

The geophysical significance of this highly radioactive material depends upon its thickness and its history subsequent to being formed. If it be of great thickness or have served to take such concentrations of radium into the structure of the earth's crust, its influence must be considerable, either as insulating the flow of heat into the ocean, as required by Joly's thermal cycles, or as providing sources of intense energy for any part of the earth's crust within which it may become incorporated.

Obviously the elucidation of such questions awaits considerable further research and more particularly the development of some device which will provide core samples, from a study of which some knowledge of the character and rate of deposition may be obtained.



**SUBMARINE EARTHQUAKE EPICENTERS, MAGNETIC  
OBSERVATIONS AT SEA, TIDAL RECORDS**



# THE STRUCTURE OF THE OCEAN BASINS AS INDICATED BY SEISMOLOGICAL DATA AND EARTHQUAKE EPICENTERS

By B. GUTENBERG

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Contribution No. 226*

## THE STRUCTURE OF THE OCEAN BASINS AS INDICATED BY SEISMOLOGICAL DATA

When an earthquake occurs, two different kinds of waves are generated: waves which travel through the interior of the earth (space waves), and waves whose energy is propagated chiefly along surfaces (surface waves). The records of both kinds of waves can be used to study certain physical properties of the several layers of the earth, especially of the earth's crust.

According to theory and to observations there are two different types of space waves: longitudinal waves, caused by the propagation of changes in volume (either compression or rarefaction, there being no difference in propagation between these cases), and shear waves (transversal waves), due to the propagation of a shear. The velocities of the longitudinal waves ( $V$ ) and of the transversal waves ( $v$ ) are connected with the bulk modulus  $k$ , the coefficient of rigidity  $\mu$ , and the density  $d$  of the material in which the wave is propagated, by the following formulae:

$$V^2 = \frac{k + \frac{4}{3}\mu}{d} \quad v^2 = \frac{\mu}{d}$$

From the seismograms we find the times of arrival of the different phases. Further, in very many cases we are able to calculate the position and depth of the focus, and the time of origin. In such cases we can find the travel time (time between occurrence of the shock and the arrival of a certain phase at the station), and plotting these travel times against the distances, we get the "travel-time curves" which allow us to find the velocities of the several kinds of waves as a function of the depth.

Unfortunately it is very difficult to get travel times of near shocks whose waves run only through

the material at the bottom of the ocean. To get true velocities, the instrument must be in contact with the material of the earth's crust beneath the ocean. It is very difficult to state how far this is true in the case of instruments installed on islands. The only observations which may fulfill such conditions to a certain degree, have been published by Angenheister<sup>1</sup> using seismograms near shocks registered at Apia (Samoa). They show that both kinds of forerunners arrive earlier than in other regions considered so far, and they were the first indication of the fact that there are large inequalities in the earth's crust.

Another way to find data on the differences in the earth's crust has been suggested by B. Gutenberg and C. F. Richter.<sup>2</sup> The amplitudes of waves reflected from the surface of the earth depend on the velocities at the point of reflection, in addition to other quantities. The observations show that waves reflected at the bottom in the Pacific basin, with the exception of a few limited areas, and in the Polar basin show usually much smaller amplitudes than waves reflected under otherwise equal conditions in the continents, the Atlantic or Indian Ocean. The maximum difference occurs for epicentral distances of about 5000 km.; at distances of this order Pacific reflections, on an average, have only about  $\frac{1}{4}$  of the amplitudes of continental reflections, indicating a higher velocity of waves in the surface layers of the Pacific.

The observations of surface waves, that is waves

<sup>1</sup> Angenheister, G., Beobachtungen an pazifischen Beben. Göttinger Nachrichten, 1921.

<sup>2</sup> B. Gutenberg and C. F. Richter, On Seismic Waves (Second Paper). Gerlands Beitr. zur Geophysik, vol. 45 (1935) pp. 280-360.

which are propagated along the surface of the earth, also can be used to find the velocities of waves in different regions. In a medium which is not homogeneous, the velocity of surface waves depends upon the period. Short waves are propagated only in a thin layer, whereas the energy of long waves is propagated in a thick layer. In general, a considerable amount of the energy of these waves is propagated in that part of the earth's crust with a thickness several times as great as the wave-length. With increasing depth the energy propagated by elastic surface waves diminishes exponentially. If, for example, we have two layers, the upper one with a thickness of ten kilometers and a velocity of three kilometers per second for transversal waves, the lower, with a velocity of four kilometers per second, surface shear waves with a period of one second (wave-length of the order of three kilometers), will be propagated with a velocity of three kilometers per second; if the wave has a period of ten seconds, the wave-length will be greater than the thickness of the layer, so a noticeable part of the energy will be propagated in the deeper layer, and the velocity of the wave will be between three and four kilometers per second. If, finally, we consider a wave with a period of 60 seconds, the wave-length (nearly 240 kilometers) will be large as compared with the thickness of the layer, nearly all the energy will be propagated in the deeper layer and the velocity of this wave will be nearly four kilometers per second. As the whole matter is somewhat complicated, we will not go into detail.

If instead of two layers with constant velocity in each we have a material in which the velocity increases with depth, the effect will be similar; in this case, too, the velocity of the waves will increase with the period. In using this method B. Gutenberg found in 1923 the difference in structure between the Pacific basin and all other regions of the earth.<sup>3</sup>

Combining the most recent data found from the various investigations mentioned so far, Gutenberg and Richter<sup>4</sup> arrived at the following conclusions:

The crust of the earth is divided in most regions into several layers, the uppermost is the layer of sedimentary rocks, with velocities of longitudinal waves from about 1 km./sec. in very unconsolidated

recent material to at least 6 km./sec. in very old, consolidated sediments. The thickness of the sedimentary layer varies locally within very wide limits; it may be totally absent, or may extend to depths of over 12 km. (Depths of this order have been found in the Los Angeles Basin by the use of applied seismic methods.) Beneath these sedimentary rocks is a layer which in many cases is known to consist of granitic rock, in which the velocity of longitudinal waves is about 5.5 km./sec. In some regions the sediments are directly underlain by basaltic rock; where data are available, usually one or two deeper layers have been recognized within the crust.

The base of the granitic layer has been found, in the continental regions where it has been studied, at depths between 15 and 20 km. In these same regions the total thickness of the crust (depth of the first major discontinuity) has been found to be from 30 to 50 km. Relatively small values for this thickness have been found for the southwestern United States, western Europe, and northeastern Japan; about average thicknesses occur in central and western North America, and in South America. The largest values found thus far are in the region of the Alps. In the Atlantic and Indian Oceans, the total thickness of the crust is only a fraction of that on the continents; the seismological data offer no evidence as to the nature of the rocks composing the crust in these areas, but in both oceans there still is a well-marked discontinuity between the crustal rocks and the mantle. There is no evident vertical discontinuity between these oceans and the adjacent continents.

In the region of the Pacific basin no marked discontinuity between crust and mantle exists; except for local accumulations of erupted basaltic material, it does not appear that the elastic constants near the rock surface differ significantly from those in the mantle. Data for the north polar basin definitely indicate the existence of a considerable area with properties similar to those of the Pacific basin.

All available evidence indicates that a continental type of structure exists in certain outlying areas of the Pacific Ocean. This is the case in the Polynesian region, including the area west of the Bonin, Marianne, and Caroline Islands. Besides, there is evidence for continental structure in a limited area in the southeastern Pacific, at considerable distance from the coast of South America.

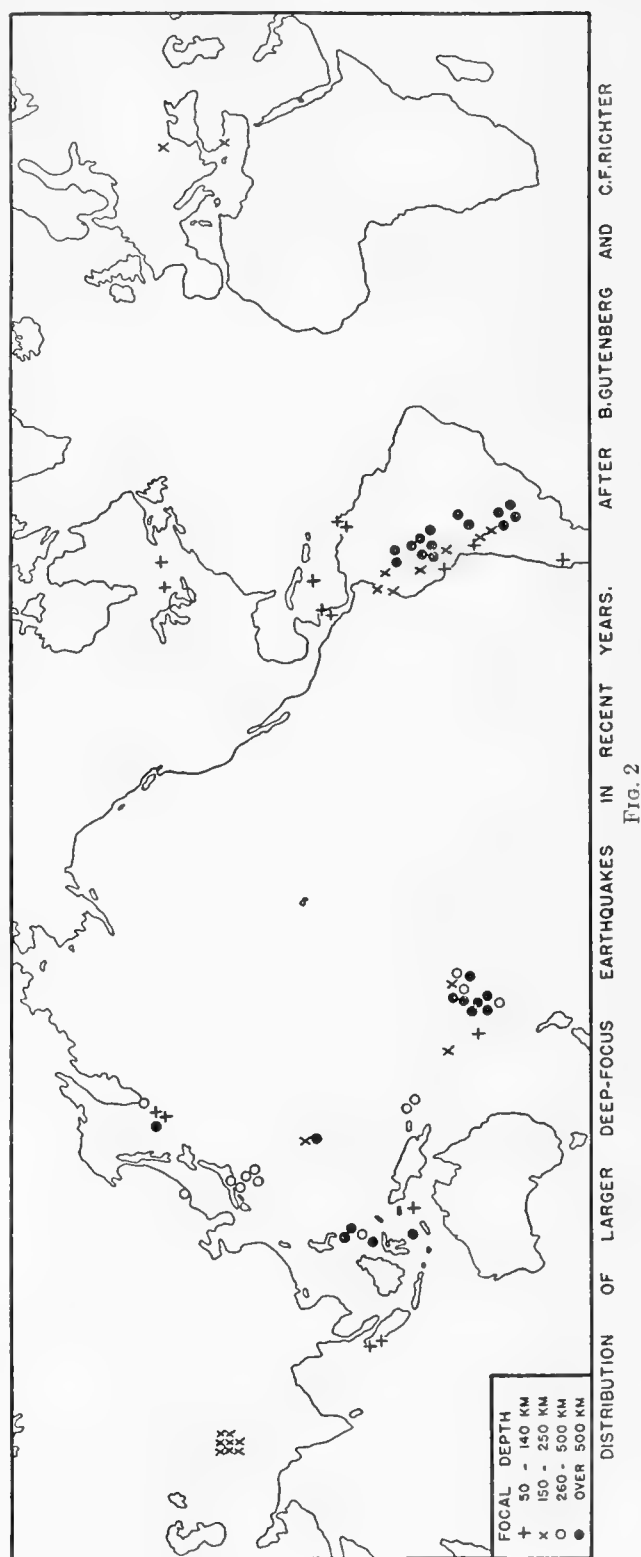
The problem, of what materials the various layers consist has not been solved completely yet. In crystalline rocks, velocities of  $4\frac{1}{2}$ –6 km./sec. have

<sup>3</sup> B. Gutenberg, Dispersion und Extinction von seismischen Oberflächenwellen und der Aufbau der obersten Erdschichten. *Physikal. Zeitschr.* vol. 25 (1924) pp. 377–381.

<sup>4</sup> B. Gutenberg and C. F. Richter, On Seismic Waves (Third Paper). *Gerlands Beiträge zur Geophysik*, vol. 47 (1936) pp. 73–131.

been found for longitudinal waves, in basalt 5-5 $\frac{3}{4}$  km./sec. It is very probable that the values found for the upper layer beneath the continental areas correspond to granite under somewhat higher pressure. No waves through more basic rocks have been investigated by means of explosions. It seems to be very probable that the continental layers consist of granite at the top, and rocks with increasing basicity at greater depths, that the bottom of the Atlantic Ocean is formed by the same types of rocks, the layers being noticeably thinner, and that the entire bottom of the Pacific Ocean and all regions of the earth at depths of more than 50 kilometers consist of a very much more basic material than is characteristic of the uppermost part of the continents.

There are other observations confirming these results. Surface waves undergo a certain amount of extinction when propagated. For very long waves, this seems to be the same everywhere. Indeed, the energy of these waves is propagated almost completely at considerable depths, the wave-length being a few hundreds of kilometers, and the structure at that depth apparently is the same in every region of the earth. But if we use short waves we find a very definite dependence of extinction upon the region. The least values are to be found at the bottom of the Atlantic Ocean and on the continents. The values for the bottom of the Pacific Ocean are somewhat scanty, as in this case epicenter and station must be situated in the ocean (Honolulu, Apia). They do not differ much from those just mentioned; however, noticeably larger loss of energy is found for waves which have traversed the boundary of the Pacific Ocean, even if the station is situated very close to the ocean. In particular, the values found from paths along the coast (Japan-Manila, Japan-Batavia) are very high, indicating that it is not a high absorption of the energy at the bottom of the Pacific Ocean that is the cause of the large values there, but the fact of the crossing of the coasts. No corresponding effects have been found from waves passing the coasts of the Atlantic Ocean. In this case, no surfaces between layers of different material must be crossed, but as we found before, and as is stated by the investigation of the extinction of surface waves, the physical coast of the Pacific Ocean (Japan-Philippines-New Guinea) is the boundary, between two completely different kinds of material. The large losses of energy of the surface waves crossing this vertical surface between the material at the bottom of the Pacific Ocean



and the very much less basic material in the upper layer of the continents, are caused by reflection and refraction of the energy which arrives there. The vertical extent of these vertical surfaces cannot be more than a few tens of kilometers, as the very long waves seem to show no effect of the kind mentioned.

Nevertheless these vertical discontinuities may affect the conditions down to a few hundreds of kilometers. Investigations on the depths of foci of earthquakes<sup>5</sup> have shown that everywhere in the earth depths of foci of not more than 40–50 km. prevail. In many earthquake regions there are found, in addition, foci at depths down to 100 km. Still greater depths occur in some earthquake regions as in the Hindu Kush (200–250 km.), in the south Atlantic (about 150 km.), Central America (about 130 km.), eastern Mediterranean region (150–200 km.), and many regions surrounding the Pacific Ocean. Earthquakes originating at depths of three hundred km. and more, however, are found only in a relatively narrow belt around the Pacific Ocean. They have been located thus far in Manchuria, Sea of Okhotsk, south of Japan (near 30°N., 140°E.), in the Central East Indies about Celebes, in the Solomon Islands, the Fiji-Kermadec area, and western South America, but not North America. (See figure.) The greatest depths, of between 600–720 km. thus far have been found in almost all these regions, but especially in the Fiji-Kermadec area and in western South America. In general the distances from the Pacific Ocean increases with increasing depth. In South America, for example, the normal shocks are close to the coast, shocks with depths between 100–250 km. are beneath the Andes and a third group of shocks with depths between 600–700 km. have been located east of the Andes. It has been found, besides, that in general the type of movement is the same regardless of

depth. That means that if we have a movement towards the north on one side of a fault near the surface, the movement is also in general in a northerly direction on the same side at larger depths. The data available so far are rather scanty in some areas; however, they leave no doubt about the fact that the Pacific Ocean basin bears a unique relation to the occurrence of deep shocks. No similar phenomena have been observed around other ocean basins nor at the bottom of the Pacific Ocean.

If we summarize our results we find that the region comprised within the limits of the Pacific Ocean as given above has one kind of structure and all other regions of the earth, perhaps excluding a part of the Arctic basin, another. In these latter parts of the earth (non-Pacific area) there is a continental layer which consists of several shells. Its thickness is about 40–50 km. under the continents but decreases towards the Atlantic and probably the Indian Ocean, where its thickness is of the order of 20 km. There is no indication that the continents have broken during any geological time and drifted apart; however, our findings would be in agreement with the assumption that in early geological times the thickness of the continental crust was different in many localities from what it is today and that plastic flow in the continental crust may have changed the distribution of land and sea in the area including all continents and the Atlantic and Indian Ocean.

The basin of the Pacific Ocean proper is a unique element of the earth's crust and its boundaries affect the layers down to many hundreds of km. As it is not evident how the continental crust could have been removed in a gradual way from the Pacific Ocean the conclusion seems to be probable that the Pacific Ocean either never has had such a crust or that it has been removed by a cosmic event.

## EARTHQUAKE EPICENTERS IN OCEANIC REGIONS AND ALONG CONTINENTAL BORDERS

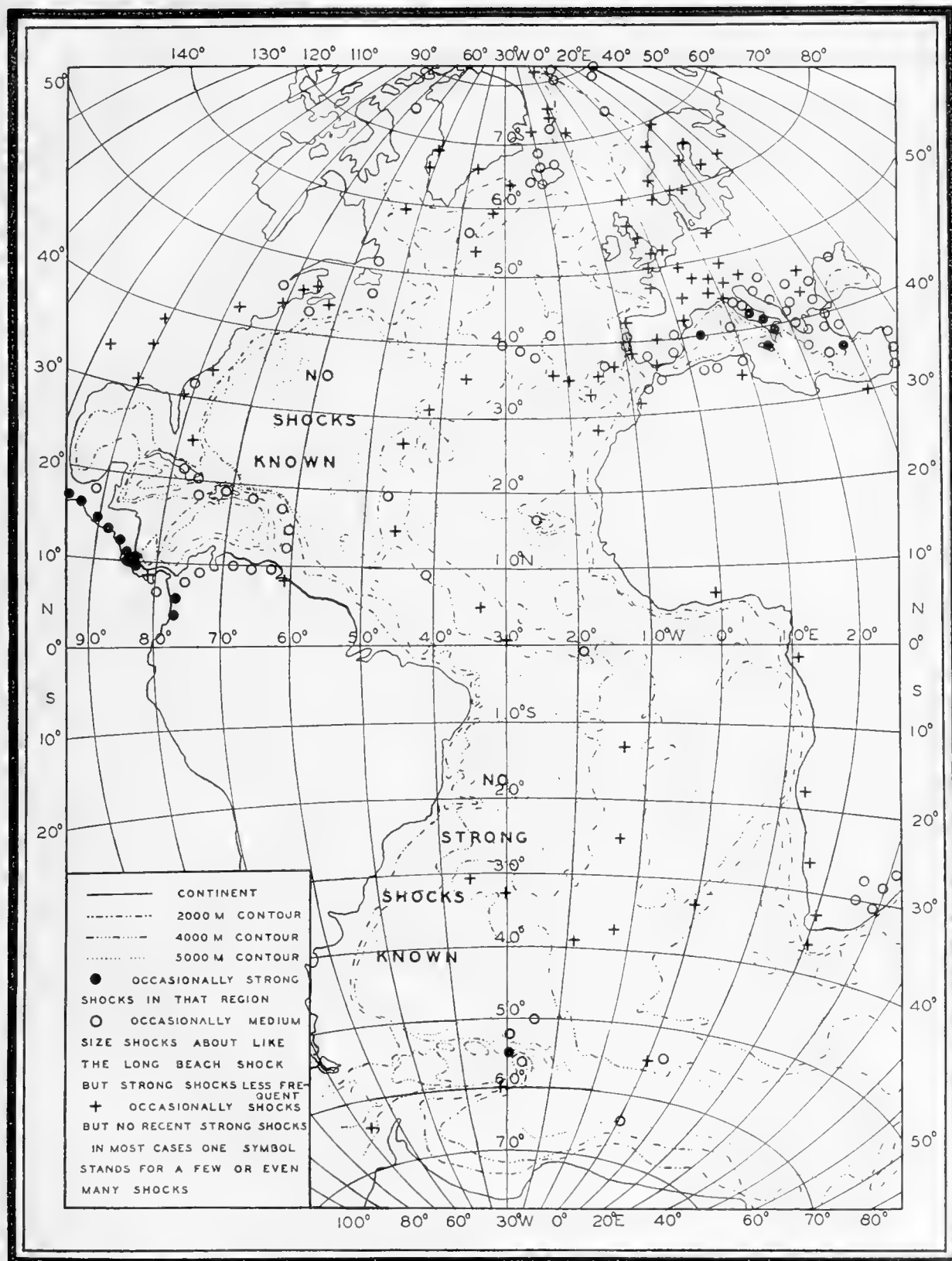
PLATES 24, 25, 26

The accompanying charts are intended to give a general idea about earthquake epicenters rather than to present a map of specific shocks. The following symbols are used:

<sup>5</sup> B. Gutenberg and C. F. Richter, Depth and Geographical Distribution of Deep-focus Earthquakes. Paper, presented at a joint session of the Geological Soc. of America, Cordill. Sect., and the Seismological Society of America at Berkeley, April 10, 1937.

- Strong shocks frequent *in that region*. In most cases one symbol stands for a few or even many shocks!
- Occasionally strong shocks *in that region*.
- Occasionally medium size shocks (about like the Long Beach shock), but strong shocks rare.
- + Occasional shocks, but no recent strong shocks.

As in many cases the epicenters are not known to a higher degree of accuracy each symbol refers to a region with a radius of a few hundred km. An

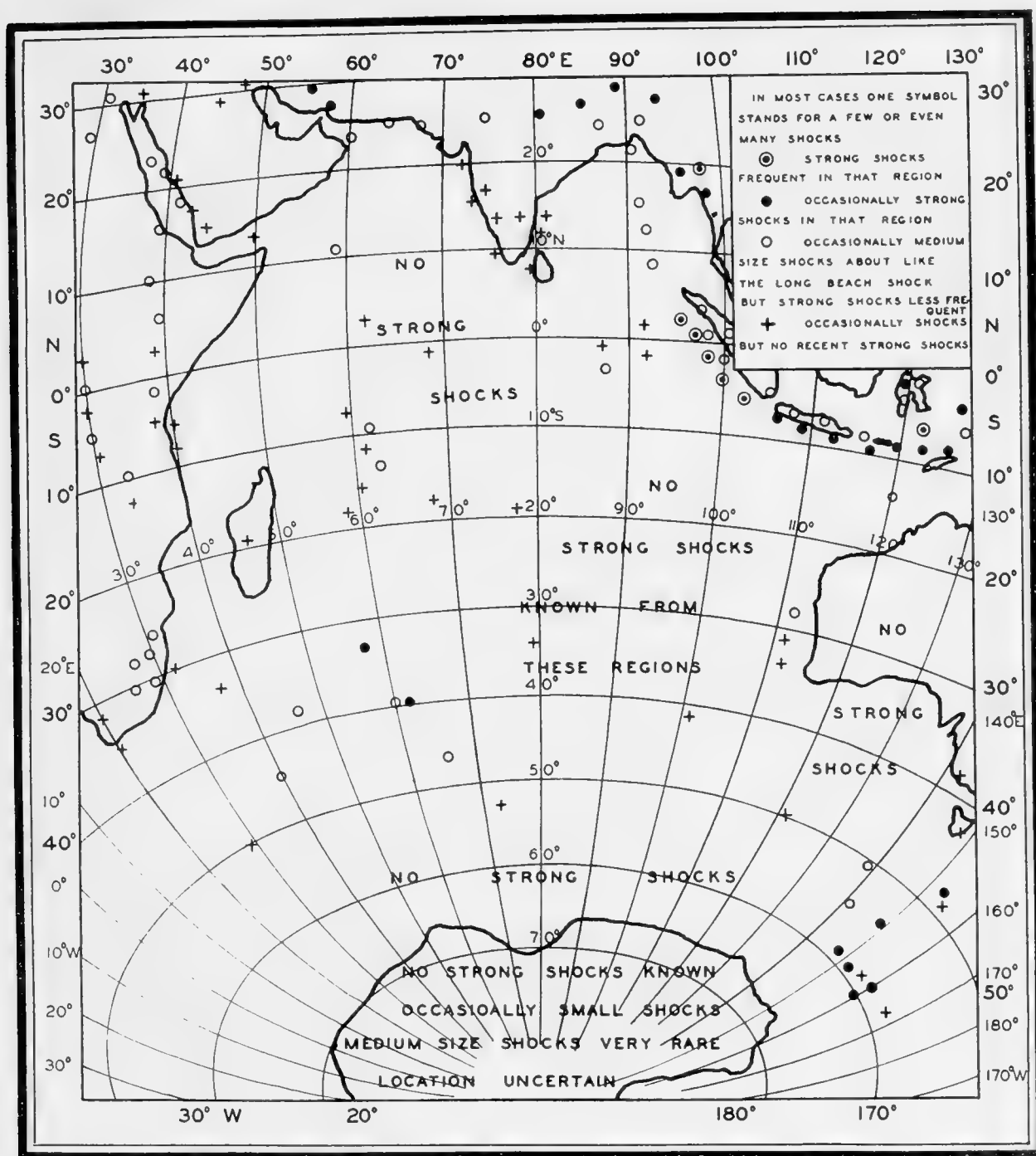


ATLANTIC OCEAN, EARTHQUAKE EPICENTERS  
(Base chart, after G. Wüst)









INDIAN OCEAN, EARTHQUAKE EPICENTERS  
(Base chart, after A. Defant.)

[illegible][illegible]

endeavor has been made to eliminate the effect of the different density in distribution of the earthquake observatories but it may not have been entirely successful. For example, the Atlantic-Arctic region, on which there have been a few detailed investigations made, may be less active than the map indicates. In the Southern Hemisphere, on the other hand, as there have been only a very few investigations, many earthquakes of moderate size may have escaped attention. But it is my belief that the difference between the

bottom of the Pacific Ocean and the surrounding regions is not exaggerated. Our records for recent years have confirmed the indicated relations, the regions with the most epicenters are more distant from us than the quiet regions.

The following is a list of the charts of the different oceans showing the position of earthquake epicenters on the sea floor and on the continental margins:

1. Chart of the Atlantic Ocean.
2. Chart of the Pacific Ocean.
3. Chart of the Indian Ocean.

# LIST OF SEISMOLOGICAL STATIONS OF THE WORLD

By N. H. HECK

*Captain, United States Coast and Geodetic Survey*

## PLATE 27

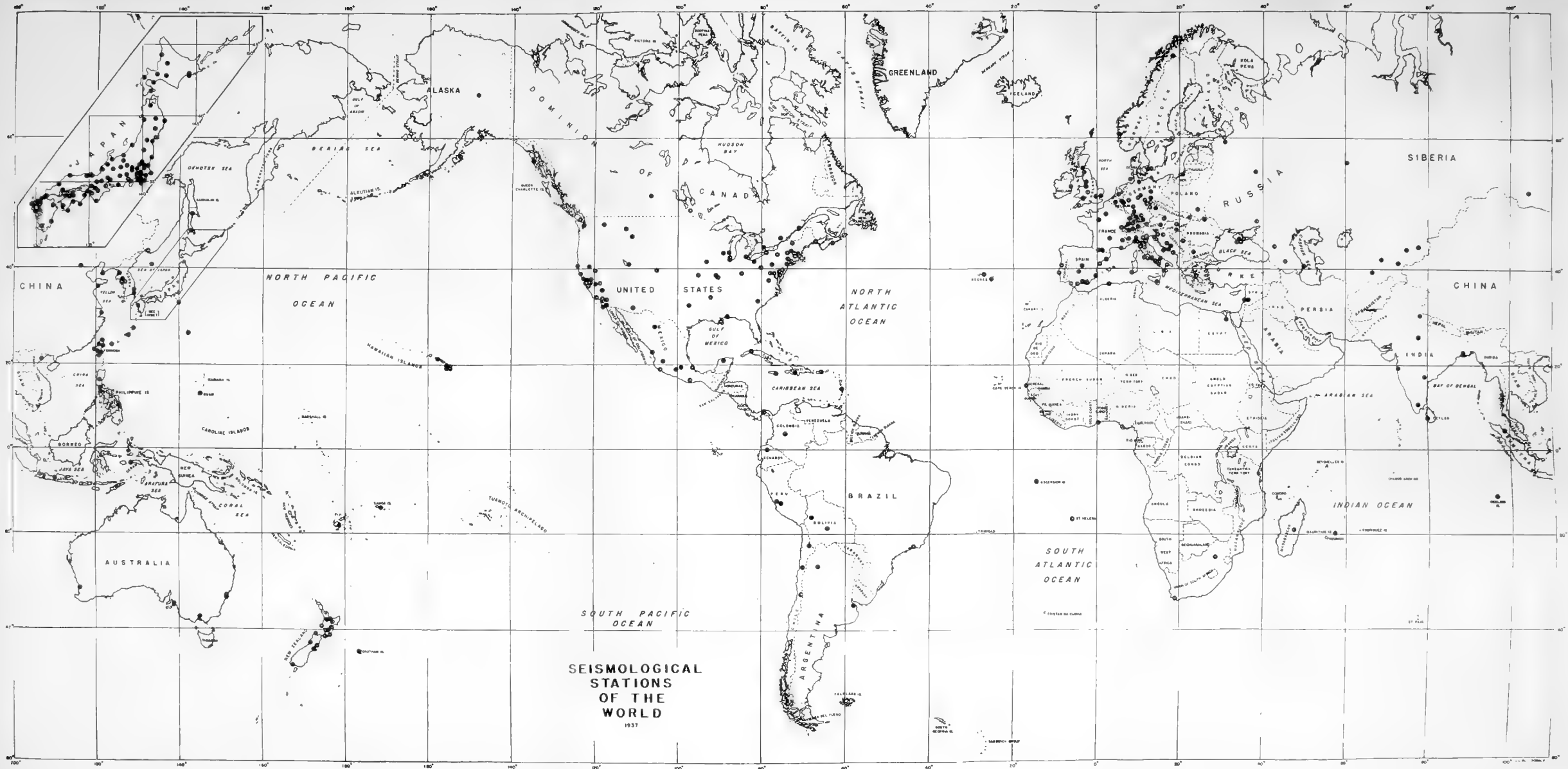
NO.	STATION	LOCATION	NO.	STATION	LOCATION
1	Aachen	Germany	48	Cambridge	USA
2	Abisko	Sweden	49	Cape of Good Hope	South Africa
3	Adelaide	South Australia	50	Cardiff	Wales
4	Accra	West Africa	51	Carloforte	Italy
5	Agra	India	52	Cartuja	Spain
6	Aidu	Japan	53	Cernauti	Roumania
7	Akita	Japan	54	Charlottesville	USA
8	Albany	USA	55	Chatham Islands	South Pacific
9	Alger-Bouzaréah	Algeria	56	Cheltenham	USA
10	Alicante	Spain	57	Chiavari	Italy
11	Alipore (Calcutta)	India	58	Chicago (Loyola)	USA
12	Alma-Ata	USSR	59	Chicago	USA
13	Almeria	Spain	60	Chihuahua	Mexico
14	Amboina	Dutch East Indies	61	Christchurch	New Zealand
15	Ambulong	Philippine Is.	62	Chur	Switzerland
16	Andalgala	Argentina	63	Chiufeng	China
17	Andijan	USSR	64	Cincinnati	USA
18	Angra do Heroismo	Azores	65	Clausthal	Germany
19	Ann Arbor	USA	66	Clermont-Ferrand	France
20	Apia	Western Samoa	67	Cleveland	USA
21	Arapuni	New Zealand	68	Coimbra	Portugal
22	Asahigawa	Japan	69	Coire	Switzerland
23	Ascension	Is. of Ascension	70	Colaba (Bombay)	India
24	Athens	Greece	71	Colombo	Ceylon
25	Awomori	Japan	72	Columbia	USA
26	Bagnères-de-Bigorre	France	73	Copenhagen	Denmark
27	Baguio	Philippine Is.	74	Copiapó	Chile
28	Baku	USSR	75	Dairen	Japan
29	Balboa	Central America	76	Dakar	West Africa
30	Barcelona	Spain	77	Dannevirke	New Zealand
31	Basle (Bâle)	Switzerland	78	De Bilt	Netherlands
32	Batavia	Java	79	Dehra Dun	India
33	Beirut	Syria	80	Denton	USA
34	Belgrade	Yugoslavia	81	Denver	USA
35	Benevento	Italy	82	Des Moines	USA
36	Bergen	Norway	83	Dubrovnik	Yugoslavia
37	Berkeley	USA	84	Ebro	Spain
38	Besançon	France	85	Edinburgh	Scotland
39	Bidston (Liverpool)	England	86	Eger	Czechoslovakia
40	Bochum	Germany	87	Eskdalemuir	Scotland
41	Bogota	Colombia	88	Florence Xim.	Italy
42	Bozeman	USA	89	Florence	Italy
43	Budapest	Hungary	90	Florissant	USA
44	Buffalo	USA	91	Foggia	Italy
45	Bunneythorpe	New Zealand	92	Fordham	USA
46	Burlington	USA	93	Fort de France	Martinique
47	Butuan	Philippine Is.	94	Frunse	USSR

## LIST OF SEISMOLOGICAL STATIONS OF WORLD

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NO.	STATION	LOCATION	NO.	STATION	LOCATION
95	Fukui	Japan	156	Keeling Islands	Cocos Island
96	Georgetown	USA	157	Keijo	Korea
97	Gifu	Japan	158	Kew	England
98	Glenmuick	New Zealand	159	Kingston	Br. West Indies
99	Göttingen	Germany	160	Kiyosumi	Japan
100	Gorje	Yugoslavia	161	Kobe	Japan
101	Graz	Austria	162	Kochi	Japan
102	Grenoble	France	163	Kodaikanal	India
103	Greymouth	New Zealand	164	Kodiak	Alaska
104	Guadalajara	Mexico	165	Kofu	Japan
105	Guam	Mariana Is.	166	Kona	Hawaii
106	Haboro	Japan	167	Königsberg	Germany
107	Haiwee	USA	168	Kosyum	Formosa
108	Hakodate	Japan	169	Ksara	Syria
109	Halifax	Canada	170	Kucino	USSR
110	Hamada	Japan	171	Kumagaya	Japan
111	Hamamatsu	Japan	172	Kumamoto	Japan
112	Hamburg	Germany	173	Kure	Japan
113	Harvard	USA	174	Kushiro	Japan
114	Hastings	New Zealand	175	Kyoto	Japan
115	Hatidyôzima	Japan	176	Kysuyu	Japan
116	Havana	Cuba	177	La Jolla	USA
117	Heerland	Netherlands	178	La Paz	Bolivia
118	Heidelberg	Germany	179	La Plata	Argentina
119	Heijo	Korea	180	Lawrence	USA
120	Helgoland	Germany	181	Leipzig	Germany
121	Helsingfors	Finland	182	Le Mans	France
122	Helwan	Egypt	183	Lemberg	Poland
123	Hikone	Japan	184	Leningrad	USSR
124	Hilo	Hawaii	185	Lima	Peru
125	Hiroshima	Japan	186	Lisbon	Portugal
126	Hof	Germany	187	Little Rock	USA
127	Hohenheim	Germany	188	Livorno	Italy
128	Hoko	Formosa	189	Ljubljana	Yugoslavia
129	Hong Kong	China	190	Lund	Sweden
130	Honolulu	Hawaii	191	Madison	USA
131	Huancayo	Peru	192	Madrid	Spain
132	Hukuoka	Japan	193	Maebashi	Japan
133	Husan	Korea	194	Makeevka	USSR
134	Husiki	Japan	195	Malabar	Java
135	Hyderabad	India	196	Malaga	Spain
136	Idzuhara	Japan	197	Manila	Philippine Is.
137	Iidia	Japan	198	Manzanillo	Mexico
138	Imola	Italy	199	Maron	Java
139	Innsbruck	Austria	200	Marseilles	France
140	Irkutsk	Siberia	201	Matsumoto	Japan
141	Ishigakijima	Japan	202	Matsuyama	Japan
142	Ishinomaki	Japan	203	Mauritius	Mauritius
143	Ithaca	USA	204	Mazatlan	Mexico
144	Ivigtut	Greenland	205	Medan	Dutch E. Indies
145	Jena	Germany	206	Melbourne	Australia
146	Jinsen	Korea	207	Mera	Japan
147	Johannesburg	South Africa	208	Merida	Mexico
148	Kabansk	Siberia	209	Meszstetten-Ebingen	Germany
149	Kagoshima	Japan	210	Milwaukee	USA
150	Kakioka	Japan	211	Mineo	Italy
151	Kalocsa	Hungary	212	Mineral	USA
152	Kamakura	Japan	213	Misaki	Japan
153	Kanazawa	Japan	214	Misima	Japan
154	Karenko	Formosa	215	Mitaka	Japan
155	Karlsruhe	Germany	216	Mito	Japan

NO.	STATION	LOCATION	NO.	STATION	LOCATION
217	Miyako	Japan	278	Pulkovo	USSR
218	Miyatsu	Japan	279	Quito	Ecuador
219	Miyazaki	Japan	280	Ravensburg	Germany
220	Mizusawa	Japan	281	Reno	USA
221	Mobile	USA	282	Reykjavik	Iceland
222	Moncalieri	Italy	283	Rio de Janeiro	Brazil
223	Montecassino	Italy	284	Riverside	USA
224	Montezuma	Chile	285	Riverview	Australia
225	Morioka	Japan	286	Rocca di Papa	Italy
226	Mostar	Yugoslavia	287	Rome	Italy
227	Mt. Hamilton	USA	288	Saga	Japan
228	Mount Wilson	USA	289	St. Boniface	Canada
229	Munich	Germany	290	St. Helena Island	Is. of St. Helena
230	Muroran	Japan	291	St. Louis	USA
231	Muroto	Japan	292	Sakai	Japan
232	Nagano	Japan	293	Samarkand	USSR
233	Nagasaki	Japan	294	San Fernando (Cadiz)	Spain
234	Nagoya	Japan	295	San Juan	Porto Rico
235	Naples	Italy	296	Santa Barbara	USA
236	Nase	Japan	297	Santa Clara	USA
237	Nemuro	Japan	298	Santiago	Chile
238	Neuchatel	Switzerland	299	Sapporo	Japan
239	New Haven	USA	300	Sarajevo	Yugoslavia
240	New Orleans	USA	301	Sasebo	Japan
241	New Plymouth	New Zealand	302	Saskatoon	Canada
242	Niigata	Japan	303	Scoresby-Sund	Greenland
243	Niihama	Japan	304	Seatoon	New Zealand
244	Nördlingen	Germany	305	Seattle	USA
245	Numazu	Japan	306	Sebastopol	USSR
246	Oaxaca	Mexico	307	Sendai	Japan
247	Obihiro	Japan	308	Seven Falls	Canada
248	Oiwake	Japan	309	Shimonoseki	Japan
249	Okayama	Japan	310	Shionomisaki	Japan
250	Okinawa	Japan	311	Sibenik	Yugoslavia
251	Omahama	Japan	312	Sikka	Japan
252	Ooita	Japan	313	Simferopol	USSR
253	Ootomari	Japan	314	Simizu	Japan
254	Osaka	Japan	315	Sion	Switzerland
255	Ottawa	Canada	316	Sitka	Alaska
256	Oxford	England	317	Sofia	Bulgaria
257	Padova	Italy	318	Spokane	USA
258	Palo Alto	USA	319	State College, Pa.	USA
259	Pare Saint-Maur	France	320	Stockton	USA
260	Pasadena	USA	321	Stonyhurst	England
261	Pavia	Italy	322	Strasbourg	France
262	Perth	Western Australia	323	Stuttgart	Germany
263	Piacenza	Italy	324	Subiaco	Italy
264	Piatigorsk	USSR	325	Sucre	Bolivia
265	Pic du Midi	France	326	Sumoto	Japan
266	Pittsburgh	USA	327	Suttu	Japan
267	Philadelphia	USA	328	Suva	Fiji Islands
268	Plauen	Germany	329	Sverdlovsk	USSR
269	Plymouth	England	330	Swarthmore	USA
270	Point Loma	USA	331	Sydney	Australia
271	Ponta Delgada	Azores	332	Tachkent	USSR
272	Port-au-Prince	Haiti	333	Tacubaya	Mexico
273	Potsdam	Germany	334	Tadotu	Japan
274	Poughkeepsie	USA	335	Taihoku	Formosa
275	Prague	Czechoslovakia	336	Taiku	Korea
276	Prato	Italy	337	Tainan	Formosa
277	Puebla	Mexico	338	Taitô	Formosa





The numbers in the foregoing table appear on the accompanying map (Plate 27) showing the positions of the seismological stations of the world, but because of the impracticability of publishing the map on a larger scale, they can be read only with a reading glass.

# MAGNETIC SURVEY OF THE OCEANS

By J. A. FLEMING<sup>1</sup>

PLATES 28, 29, 30

The large portion of the Earth's surface covered by the oceans makes the determination of accurate values of the magnetic elements at sea a major objective of the world-wide magnetic and electric survey. It was not until 1905 that full realization of this objective had its beginning through the systematic oceanic magnetic survey then sponsored by the Carnegie Institution of Washington through its Department of Terrestrial Magnetism.

The first attempt to accomplish a magnetic survey at sea was the expedition of Halley between 1698 and 1700. He was placed in command of the *PARAMOUR PINK* and was told by King William III to proceed with her "on an expedition to improve the longitude and the variations of the compass." Halley made several voyages in the North and South Atlantic oceans determining magnetic declination only—instruments for measuring magnetic inclination and magnetic intensity at sea had not then been devised. The results were embodied in Halley's chart "Lines of equal magnetic variation" of the Atlantic for the year 1700—the first isomagnetic chart. The next really important undertaking was the expedition under the general direction of Sabine of the *EREBUS*, the *TERROR*, and the *PAGODA* during 1840–45, chiefly in southern waters. On these all three magnetic elements were observed, the Fox dip-circle for measuring the magnetic inclinations and intensity at sea having been just devised. The Austrian frigate *NOVARA* measured magnetic declination while circumnavigating the globe in 1857–60. During the notable cruises of the *CHALLENGER* in 1872–76, and of the *GAZELLE*, a German vessel, in 1874–76, observations of the three magnetic elements were made over various oceans. Magnetic observations at sea were also made more recently by the naval services of various countries and by later Antarctic expeditions, notably the *DISCOVERY* and the *GAUSS*. The accompanying plates 28 and 29 and fig. 3 show the tracks of chief

vessels on which magnetic observations were made during 1839–1916.

All these observations were of varying degrees of accuracy set by available instruments and by the disturbing factors originating in the magnetic character of the vessels, while their distribution, both as regards position and epoch, was not such as to yield coördinated charts applying to definite periods. Therefore, when planning in 1904 for the magnetic and electric survey of the Earth the Department of Terrestrial Magnetism, Carnegie Institution of Washington, gave careful consideration to the oceanic survey.

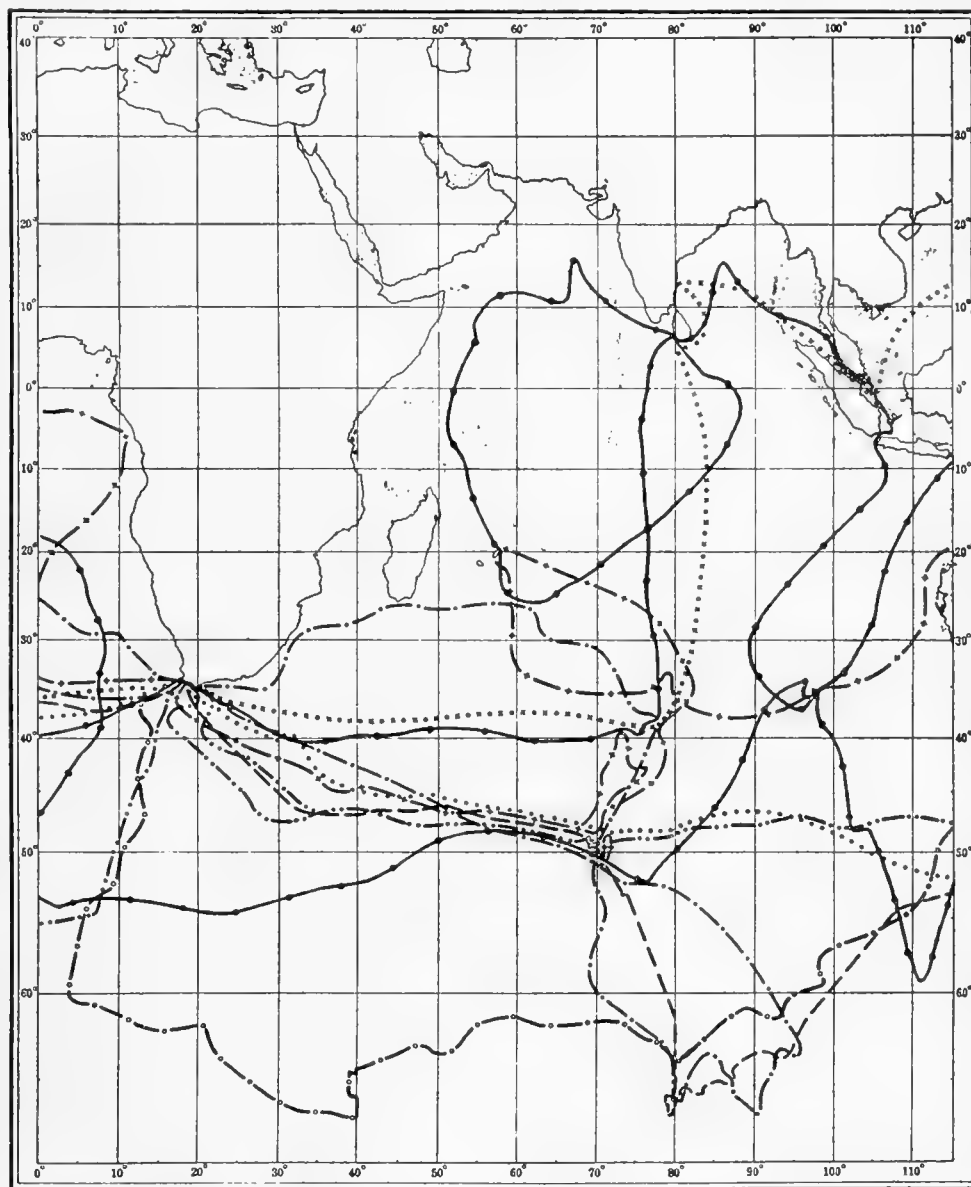
The Institution's earliest work at sea was done with the chartered vessel *GALILEE* during 1905–08. The experience gained during her three cruises proved conclusively that oceanic observations of the magnetic elements sufficient for practical and scientific needs could be assured only by a vessel designed specially for such work. The *CARNEGIE* was designed in 1908 primarily for magnetic and electric surveys and investigations and her construction and equipment were completed in 1909. The first of the seven cruises of this unique vessel during 1909–29 in all oceans was begun in 1909. The theoretical and practical values of the knowledge acquired and of the resulting discussions of the Earth's magnetic and electrical fields are attested by many expressions of appreciation made by the leading hydrographical establishments and by investigators of geophysics in all countries.

The observational work accomplished before the destruction of the *CARNEGIE* by explosion and fire at Apia, Western Samoa, November 29, 1929, was obtained during the seven cruises which aggregated 297,579 nautical miles. The data obtained during these cruises and the three previously made by the *GALILEE*, include declination at 3844 points, inclination and horizontal intensity at 2321 and 2322 points, respectively, and atmospheric-electric elements on 1913 days. The extent of the Institution's survey on land and sea is shown by plate 30.

<sup>1</sup> Director, Department of Terrestrial Magnetism, Carnegie Institution of Washington.

While more information on secular-variation changes in the Earth's magnetism is required for navigation, yet future magnetic and electric data over the oceans are far more necessary to advance

continue the work of the CARNEGIE because further surveys of like accuracy will enhance the theoretical value of the work already done. As an example, attention may be called to the apparent diminution



Tracks of Chief Vessels on Which Magnetic Observations Were Made in the Indian Ocean, 1839-1916

Carnegie, 1911-1916 ———●———	Erebus and Terror, 1839-1843 ———●———	Pagoda, 1845 ———●———
Novara, 1857-1860 .....●.....	Challenger, 1872-1876 - - - - -●- - - - -	Gazelle, 1874-1876 ———●———
Gauss, 1902-1903 ———●———	Discovery, 1902-1904 .....●.....	

FIG. 3

theoretical studies. The full value of magnetic results of the few earlier expeditions under various governments has never been attained because of the shortness of the cruises. It is of first importance to

of the intensity of the Earth's magnetic field discovered by the Department's investigations of the data thus far obtained, this diminution being marked over oceanic areas, especially in the Southern

Hemisphere. The interpretation of such data doubtless will be important in geophysical and geological research to advance understanding and interpretation of Earth phenomena.

For example, from observed earthquake-wave velocities and reflections for different regions and depths the crustal layer, which under most of the

tribution of magnetic secular-variation agrees with, that of land-areas (see figs. 4 and 5, after Fisk, based upon data from 75° north to 65° south<sup>2</sup>)—as witness the moderate rates of annual change over the Pacific as compared with those over the Atlantic and adjoining continental areas. Further data bearing on correlation thus indicated between

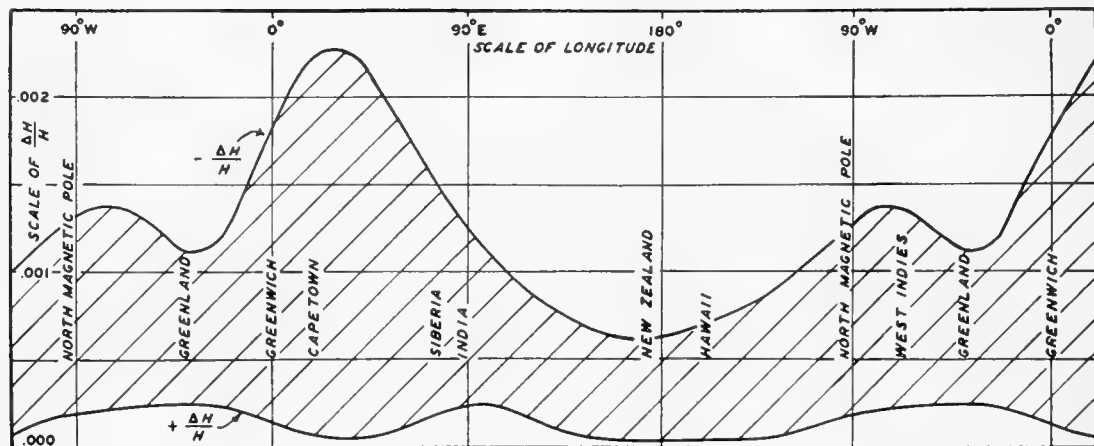


FIG. 4. LONGITUDINAL DISTRIBUTION OF PROPORTION OF ANNUAL CHANGE ( $\Delta H/H$ ) OF HORIZONTAL INTENSITY

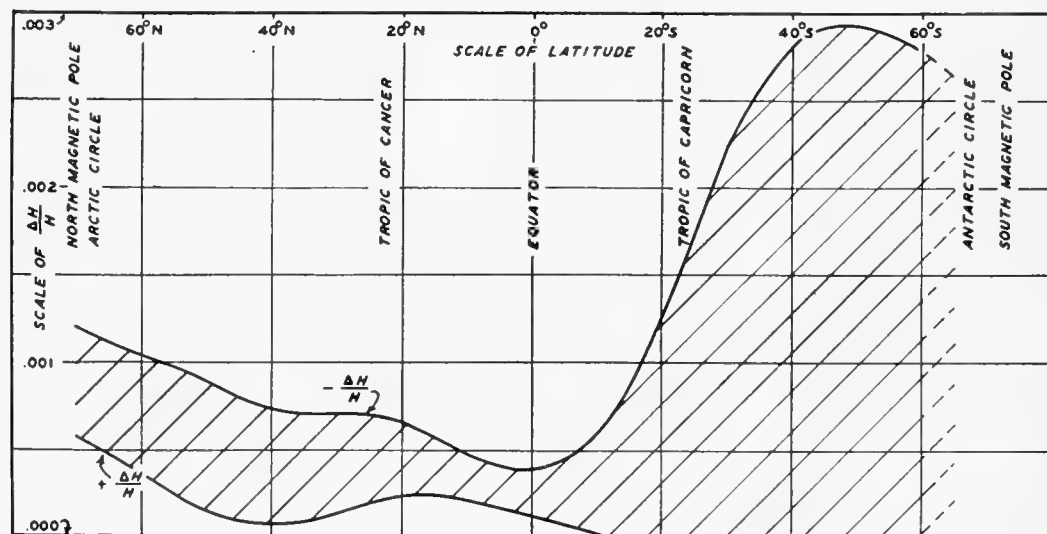


FIG. 5. LATITUDINAL DISTRIBUTION OF PROPORTION OF ANNUAL CHANGE ( $\Delta H/H$ ) OF HORIZONTAL INTENSITY

continental and water-covered continental structures is about 25 km. thick, is indicated as either lacking or quite thin under the Pacific Ocean including possibly the Arctic region. Under the Atlantic and Indian oceans this layer is of appreciable depth. Thus under the Pacific Ocean the basic surface of the Earth's mantle is practically exposed. There then we may expect different geological and geographical properties from those found elsewhere. Thus the observed longitudinal and latitudinal dis-

tribution of the secular-change activity promise conclusions concerning secular-variation processes localized in the crustal layer and

<sup>2</sup> In these graphs showing distribution of annual change ( $\Delta H/H$ ) of magnetic horizontal intensity the lower curves represent the average positive values of  $\Delta H/H$  in each lune between the meridians (upper figure) and between its parallels at 20-degree intervals while the upper curves represent the numerical magnitude of the average negative values. Thus the shaded areas between the curves are measures of the excess of the negative over the positive annual change.

only where this layer is present. Thus continued secular-variation surveys at sea should bring together seismic and magnetic methods of approach to crustal adjustments and possibly gravimetric work.

On the side of practical application the increasing use of the oceans in the commerce of nations by sea and air makes the continuation of the survey a matter of international concern and benefit.

Those theoretical investigations demanding continuation of the oceanic survey in terrestrial magnetism include, among others, the following:

(a) Determination of secular-variation of progressive changes of the Earth's magnetic field involving particularly their accelerations which the data accumulated so far indicate can not be extrapolated reliably over periods as long as five years. A definite control is necessary for a number of epochs to facilitate the investigation of causes producing

during the cruises of the *CARNEGIE* is desirable in several directions. Among these are the following:

(a) Additional determinations to establish changes in the values of the atmospheric-electric elements with geographic position. Such distribution-data are necessary for the further investigations of the origin and maintenance of the Earth's electric charge and of the relations to its magnetic condition.

(b) More and widely distributed determinations of the diurnal variations in atmospheric electricity particularly to confirm the discovery that such variations in the potential gradient progress with universal time—a deduction first indicated from results obtained on the *CARNEGIE*. Conditions at sea for such work are superior to those on land where variable meteorological disturbances and topography mask the true characteristics of the phenomena.

(c) Determinations and investigations of earth-currents—a field not yet touched at sea. Two outstanding characteristics of the water-area of the globe are (1) its extent and (2) its far greater homogeneity as compared to the land-area.

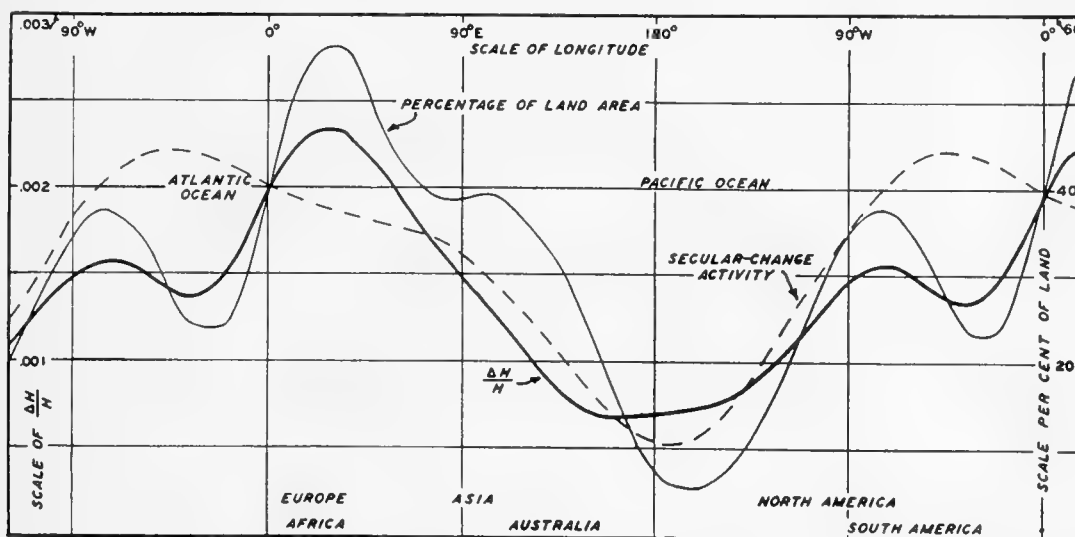


FIG. 6. VARIATION WITH LONGITUDE OF  $\Delta H/H$  (annual change averaged without regard to sign), OF THE DISTRIBUTION OF THE PROPORTION OF LAND AND WATER AREAS, AND OF SECULAR-CHANGE ACTIVITY APPROXIMATELY DETERMINED BY THE DENSITY OF THE DISTRIBUTION OF ISOPORIC LINES

and governing these progressive changes which, it appears, would be favored by accurate knowledge of their accelerations and distribution. The importance of the determination of secular-variation over the oceans may be readily seen by a study of figure 6. Figure 7 showing world distribution of foci of rapid annual change of magnetic declination also emphasizes the continued need for secular-variation data at sea.

(b) The study of regions of local disturbance and particularly of those indicated by the work of the *CARNEGIE* over "deep-sea" areas including accompanying determination of oceanic depths by sonic-sounding devices and of gravity.

(c) The determination of additional distribution-data in a few large areas not already covered.

As regards the domain of terrestrial electricity continuation of the survey of the oceans initiated

The question arises whether the theoretical requirements might not be met in a less expensive way than through construction and maintenance of vessels similar to the *CARNEGIE*. A careful study was made by the Department after the loss of the *CARNEGIE* to determine what might be done in an attempt to control magnetic secular-variation data through observations on land only over the oceans between 60° north and 60° south latitude. [In any case requisite additional data on land- and ocean-areas in the polar regions beyond the parallels of 60°—less than one-seventh of the surface of the globe—can be secured only, as in the past, through or in coöperation with special expeditions by land or

air.] The maximum control so effected would result from 150 secular-variation stations along the coasts of the continents and on islands; about 90 of these have been occupied by the Carnegie Institution of Washington one or more times during 1905 to 1937, but the remainder include the more inaccessible islands of the oceans and are subject, generally, to magnetic local disturbance. Such disturbance introduces uncertainties both in the effects upon secular-variation changes and in the relation between the normal and the island value, even though the inaccessibility of stations insures possibility of exact reoccupations. The reduction to common epoch would be more difficult because of the length of intervals between reoccupations and

by 900 miles in the southeast Indian to the south of Australia. [Local disturbances existing at many of the possible stations on islands, which doubtless would make data from a majority of them unsuitable for discussion actually make these areas greater than indicated in Figure 7.] The need of continued work at sea is emphasized because these areas involve portions of the Earth's surface where there are at present the greatest irregularities in the progressive character of the secular variation, namely in the central and south Atlantic, Indian, north Pacific, east central Pacific, and south Pacific oceans.

Failure to provide a vessel suited for magnetic and electric observations also would mean that future data for the distribution of the absolute values

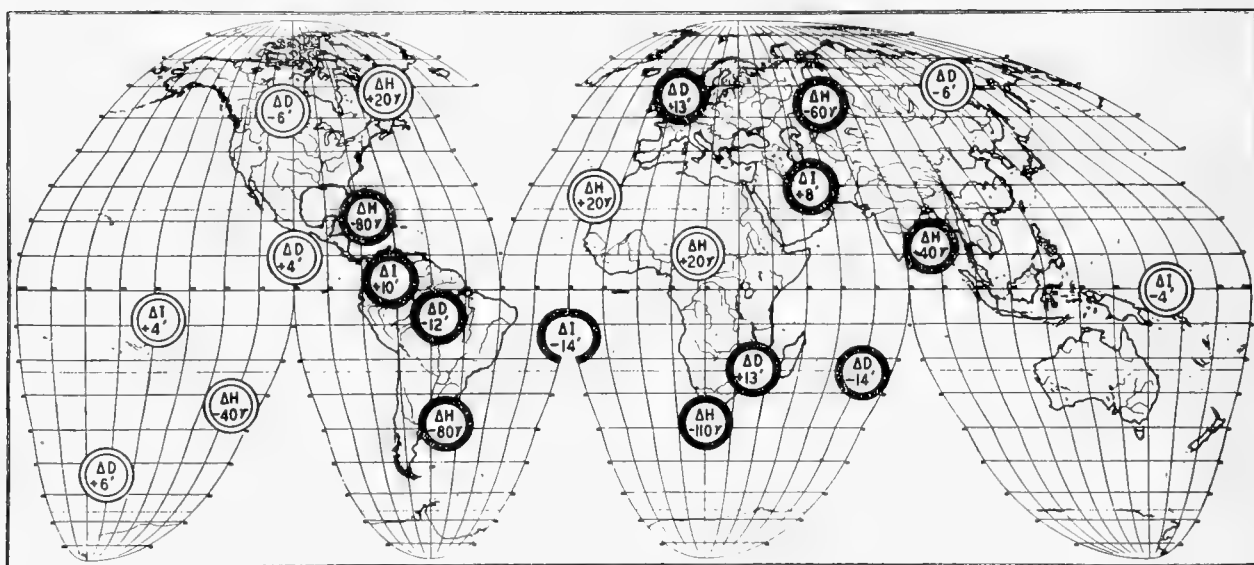


FIG. 7. DISTRIBUTION OF FOCI OF RAPID ANNUAL CHANGE OF THE MAGNETIC DECLINATION, INCLINATION, AND HORIZONTAL INTENSITY, APPROXIMATE EPOCH 1920-1925

of the lack of the better distribution of data which would result from observations at sea. The study shows that the regions for which the necessary data for the continued theoretical investigations would be lacking are very large even if the complete scheme for control by observations on land could be carried out as based on the assumption that the distribution of secular-variation stations need not be greater than one every 800 miles. These areas (see fig. 8) approximate 3400 by 800 miles in the north Pacific, 3600 by 1500 miles in the east central Pacific, 3600 by 1800 miles in the south Pacific, 600 by 600 miles in the north Atlantic, 2400 by 800 miles in the middle north Atlantic, 1900 by 900 miles in the west south Atlantic, 1500 by 700 miles in the east Indian, 3600 by 750 miles in the central Indian, and 2400

of the atmospheric-electric elements would be limited to relatively few stations obtained at relatively great expense since, to eliminate, for short series of observations, the topographic and meteorological conditions at stations on land, only selected points in wide bays or estuaries could be used where it would be possible to observe on floats. Atmospheric-electric observations could be obtained on board ordinary vessels and doubtless some of the maritime companies would be ready to permit installation of the special equipment at reasonable cost, but it is not feasible to obtain on such vessels the calibration-observations required for the determination of the necessary reduction-factors nor, despite earnest desire to coöperate, is it possible to control the deck-space and eliminate vitiating

effects of smoke and exhaust gases. Furthermore, it would be necessary to repeat such work and control of such conditions on many vessels in order to accomplish the requisite distribution of observations over the oceans. Despite the considerable expense that would be incurred, the accumulated data would be subject to many uncertainties and would involve an expenditure of time for reductions in the office out of all proportion to that required were there a survey-vessel available.

Because of the great desirability of continuing the operation conducted for a quarter-century by the vessels of the Carnegie Institution of Washington,

in certain regions been determined. One of the first tasks, therefore, of the *RESEARCH* will be the repetition of the observations of the *CARNEGIE* in these regions to determine the secular change so that the isogonic charts may be corrected to date and prepared for succeeding epochs. This vessel is to be of the same beam as the *CARNEGIE* and slightly greater overall length. The proposed instrumental equipment will parallel closely that used on the *CARNEGIE* as it has not appeared advisable to depart from designs gradually evolved from the experience of many years of observational work at sea.

With the completion of the *RESEARCH* and its

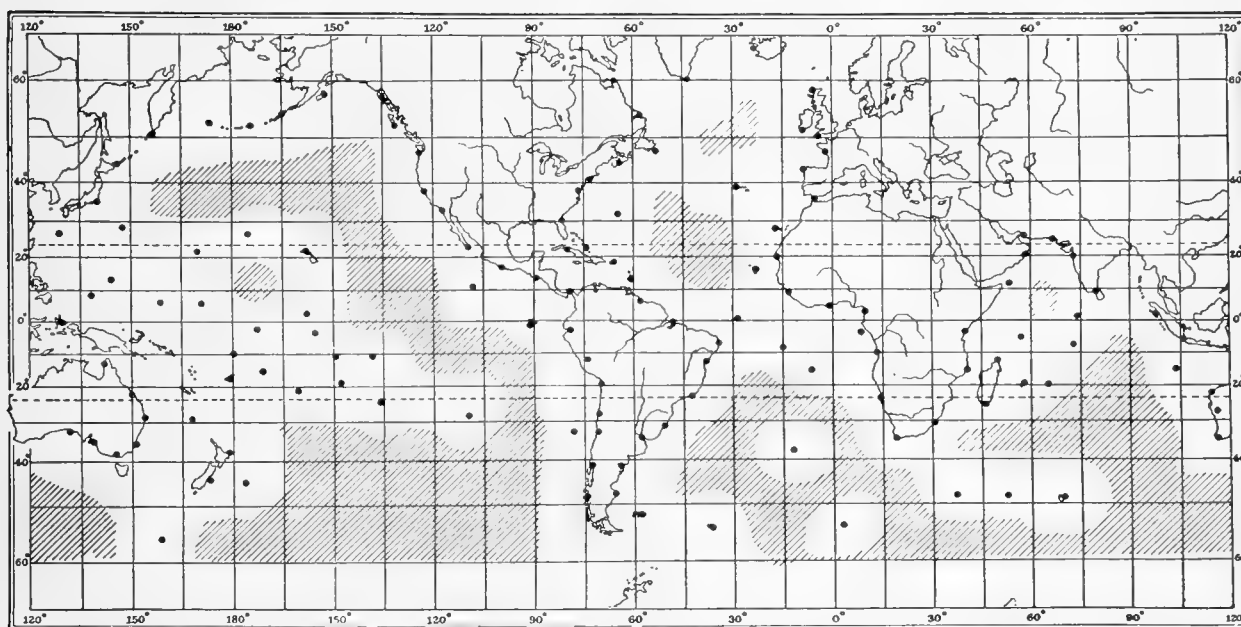


FIG. 8. SHOWING OCEANIC AREAS (SHADED) BETWEEN PARALLELS OF 60° NORTH AND SOUTH LATITUDE FOR WHICH SECULAR VARIATION OF MAGNETIC ELEMENTS COULD NOT BE CONTROLLED BY LAND STATIONS ON CONTINENTS AND ISLANDS

it is gratifying that, in view of the Institution's decision not to replace the *CARNEGIE* by a similar vessel, the British Admiralty has designed and in September 1936 placed a contract to build a non-magnetic vessel, to be named *RESEARCH*. The chief reason for this action on the part of Great Britain was found in her world-wide maritime interests. Magnetic charts published for the last two decades by the American, British, French, German, and other governments for use at sea have been based in an increasingly large degree upon data obtained by the *CARNEGIE*. There are now serious gaps in the present data which would have been filled had the *CARNEGIE* completed her last cruise and had the rapid change in the secular variation

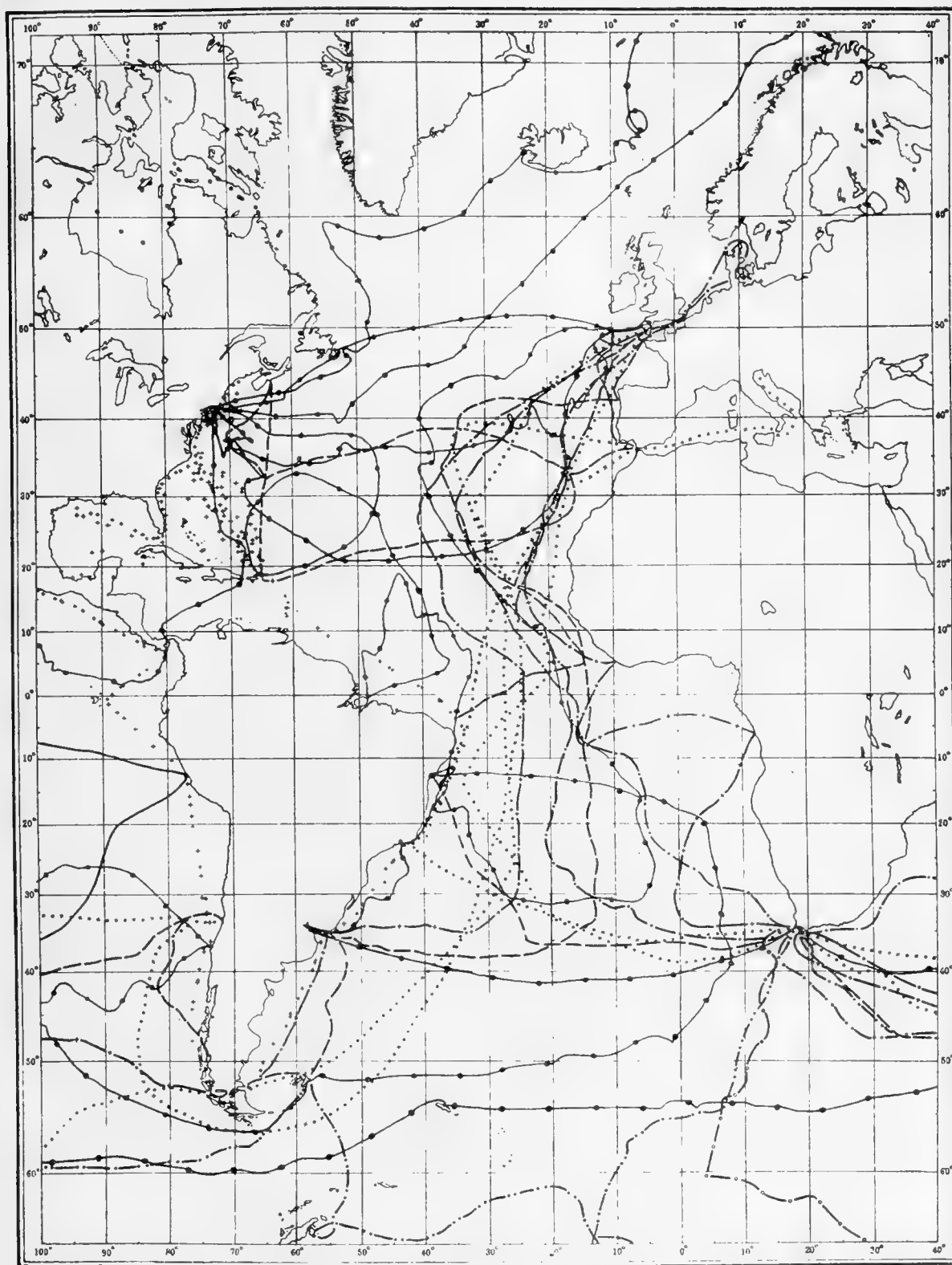
continuation of the oceanic survey we may look forward to further advance of geophysical research. Not only will the resulting additional observations increase the opportunities of geophysical investigations but they will enhance the value of the earlier data.

The task of the geophysical survey of the oceans is so great that other hydrographic services of maritime nations should be stimulated by the action of the British Admiralty to provide similar vessels with equipment and personnel to take their appropriate share in the execution and in the coordination of such service. Resolutions adopted after thorough discussions by the Commission of Terrestrial Magnetism and Atmospheric Electricity of the Inter-

national Meteorological Organization at Warsaw, Poland, in September 1935, and by the Association of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics at its triennial assembly at Edinburgh in September 1936, urge and recommend that other maritime nations should consider the construction of such

non-magnetic vessels. It is to be hoped that our own United States may assume its share in obtaining additional oceanic data to the further enrichment of our knowledge of the Earth's science.

*Department of Terrestrial Magnetism, Carnegie  
Institution of Washington.*



Tracks of Chief Vessels on Which Magnetic Observations Were Made in the Atlantic Ocean, 1839-1916

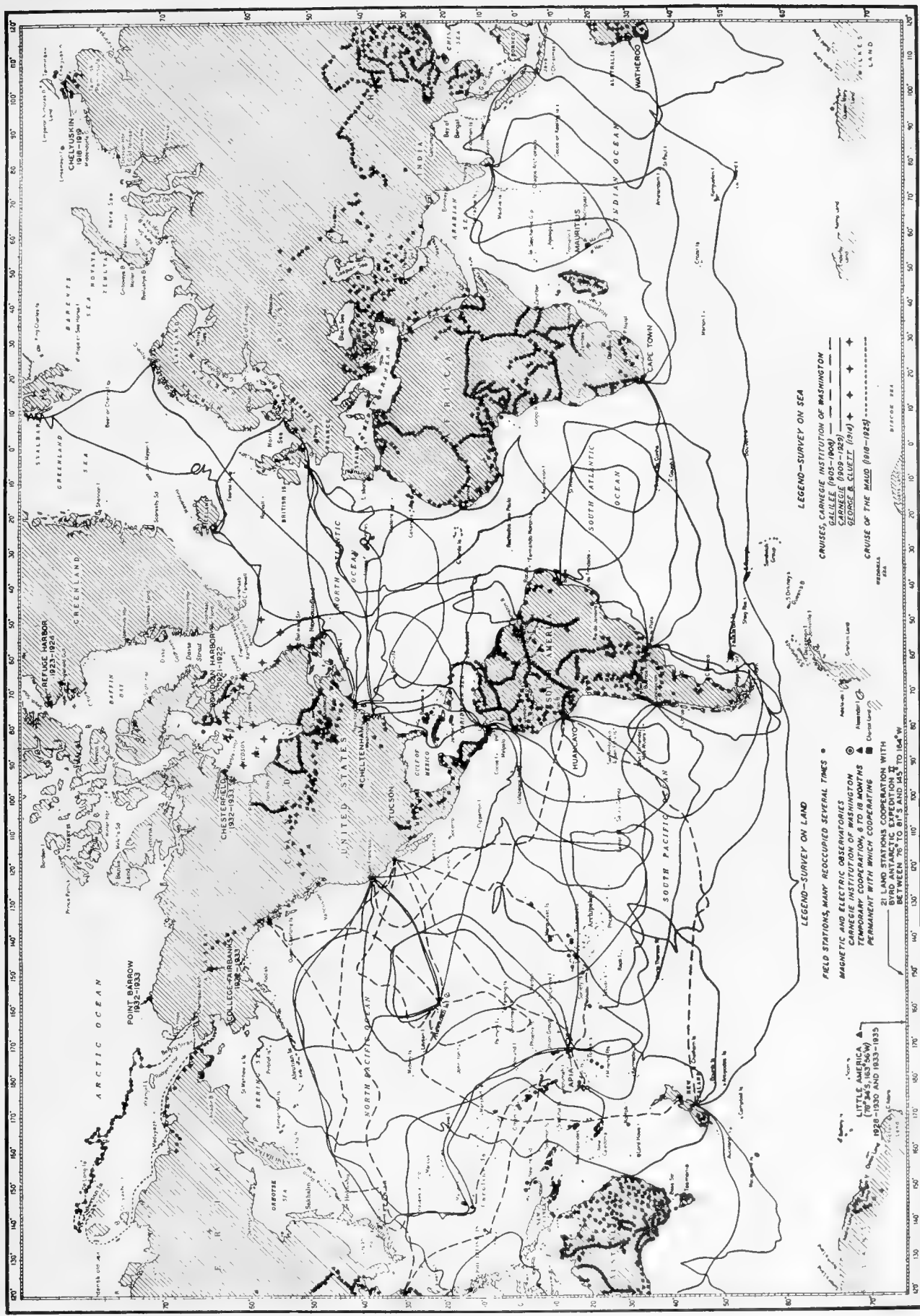
Galilee, 1908 (Pacific) —————	Carnegie, 1909-1915 ————●———	Cluett, 1914 .....●.....
Erebus and Terror, 1839-1843 ————	Challenger, 1872-1876 ————	Pagoda, 1845 ————●———
Novara, 1857-1860 .....●.....	Discovery, 1902-1904 .....●.....	Gazelle, 1874-1876 .....●.....
Gauss, 1902-1903 .....●.....		Coast and Geodetic Survey, 1903-1915 .....●.....





Galilee, 1905-1908	—————	Carnegie, 1911-1916	—————	Cluett, 1914 (Atlantic) *	.....
Erebus and Terror, 1839-1843	.....	Novara, 1857-1860	.....	Challenger, 1872-1876	-----
Gazelle, 1874-1876	.....	Discovery, 1902-1904	.....	Coast and Geodetic Survey, 1903-1915	+++++





WORLD-MAGNETIC AND ELECTRIC SURVEY, DEPARTMENT OF TERRESTRIAL MAGNETISM, CARNEGIE INSTITUTION OF WASHINGTON, 1905-1937



# TIDES

By H. A. MARMER

*United States Coast and Geodetic Survey*

PLATES 31, 32

With regard to systematic tidal investigations at the present time, it may be said that with but few exceptions they are being carried on by governmental agencies and not by educational or research institutions. Furthermore, the governmental agencies engaged in tidal work are carrying on this work primarily as a necessary adjunct to other work. For example, in the United States the tidal work is centered almost exclusively in the Coast and Geodetic Survey which carries on this work primarily in connection with its hydrographic and geodetic surveying operations. The three major oceanographic research institutions in the United States do not include tidal investigations in their programs of study, although each of these coöperates with the Coast and Geodetic Survey in maintaining a tide station at its institution.

This almost complete indifference on the part of educational and research institutions to tides has naturally acted to limit drastically the number of students of tidal phenomena. Furthermore, the governmental agencies engaged in tidal work are necessarily interested in its technical rather than in its scientific aspects. As a consequence, tidal investigations in recent years have been largely concerned with technical problems rather than with scientific research.

The status of tidal investigation at the present time, so far as the observations are concerned, is well pictured in the two maps shown here which are generalized from a manuscript chart showing the locations of tide stations given in Special Publication No. 31 of the International Hydrographic Bureau, now in press. The red dots indicate tide stations in operation in 1935, the blue dots the location of tide stations at which observations have been made previously. Because of the small scale of the chart, red lines are used to indicate a number of stations in operation along the particular coast, while blue lines indicate the location of a number of stations which were in operation in previous years.

These maps do not attempt to show all places where tide observations have been made, but rather the places where systematic observations have been carried on. Since the tide varies from day to day, month to month, and year to year, it is obvious that scattered observations of a few days or even more can give nothing but qualitative information relating to the tide. Such scattered observations on the range and time of the tide are not shown on these maps as they do not furnish sufficiently precise data and do not lend themselves readily to the harmonic analysis, the results of which are of primary importance in tidal research. In passing, too, it may be noted that no attempt has been made to indicate the locations in the Arctic and Antarctic where tide observations have been made.

A glance at these maps brings out immediately two important facts. First, that along large stretches of the coast there are no tidal observations available. And secondly, out in the open sea observations are wholly wanting except for a few islands.

With regard to the continental coast, it may reasonably be expected that such observations will become available over the greater part of the world in the not distant future in connection with the hydrographic surveys and with the securing of tidal data for tide tables.

In the open sea the problem of securing tide observations is a difficult one. While pressure gages have been used in shallow depths, they do not lend themselves for observations at considerable depths. But advantage might be taken of the islands scattered through the oceans. The cost of a tide gage is relatively little and its operation is extremely simple. After installation it can be maintained in operation by a local resident.

Tide observations in the tropical regions are especially needed not only to bring out the local tidal features and their relations to the tidal phenomenon as a whole, but also in connection with the

question of changes in sea level which is of basic importance in connection with the coral reef problem.

Quite apart from the purely tidal problems for which tide observations are necessary, such observations furnish the basic data for problems of a wider scope. One of these may be mentioned here, namely, that relating to sea level. From long continued tide observations it can be determined whether the relative elevations of land to sea at any given place are changing. This problem is obviously of importance in various practical and theoretical fields.

Two tidal bibliographical undertakings which are now being carried out on a comprehensive

scale should be mentioned in this connection. The first, by the Committee on Tides of the Association Internationale d'Océanographie Physique. This bibliography lists in a concise form all the publications issued during a period of years under definite groupings which are of especial value to research students of the subject. The second is the List of Harmonic Constants issued from time to time by the International Hydrographic Bureau, which covers the whole world. Mention should also be made of a publication on Sea Level and Its Variations which will give the monthly and annual values of sea level at various tide stations throughout the world and which is now in press, being published by the above-named Committee on Tides.



TIDAL STATIONS, ATLANTIC AND INDIAN OCEANS AND CONNECTING WATERS





TIDAL STATIONS, PACIFIC OCEAN AND CONNECTING WATERS



**RESULTS OF MARITIME GRAVITY RESEARCH, 1923-32**



# RESULTS OF MARITIME GRAVITY RESEARCH, 1923-32

BY DR. F. A. VENING MEINESZ

*Professor of Geodesy, University of Utrecht*

PLATES 33, 34, 35, 36

## GENERAL STATEMENT

This report has been made at the request of Prof. W. Vaughan, for inclusion in his report on the status of oceanographic research.

The following expeditions have been made by the writer for determining gravity at sea:

- 1923, from Holland via Suez to Java o/b Hr. Ms. Subm. K II
- 1925, from Holland to Alexandria, o/b Hr. Ms. Subm. K XI
- 1926, from Holland to Java via Panama, o/b Hr. Ms. Subm. K XIII
- 1928, from Washington to the West Indies, o/b U. S. Subm. S 21
- 1929/30, three expeditions in the East Indies, o/b Hr. Ms. Subm. K XIII
- 1931, research in the North Sea o/b Hr. Ms. O 13
- 1932, expedition in the West Indies o/b U. S. Subm. S 48
- 1932, expedition in the Atlantic o/b Hr. Ms. Subm. O 13

The expeditions o/b Dutch submarines have been made for the Netherlands Geodetic Commission, the expedition o/b the U. S. Subm. S 21, where the writer was coöperating with Dr. Fred E. Wright and Elmer B. Collins, for the Carnegie Institution of Washington and that o/b the U. S. Subm. S 48, during which the writer was assisted by Dr. Harry Hess and by Mr. Townsend T. Brown, for the International Expedition to the Bahamas under the Directorship of Dr. Richard M. Field.

The observations have been made by means of the multiple pendulum method, which is described and discussed at length in "Theory and Practice of Pendulum Observations at Sea," by the writer (published by the Netherlands Geodetic Commission, Waltman, Delft) and which is likewise treated of in the publication of the U. S. Naval Observatory of the Expedition of the U. S. S. S-21.

In 1931 the Italian Navy has organized an expedition in the Western part of the Mediterranean;

Prof. Gino Cassinis took the direction of the gravimetric research. The results of this expedition are not yet available.

Most of the results of these expeditions are represented on the three accompanying maps, one map giving the results of the expeditions of 1923, 1925, and 1926 between Holland and the Indies, another containing the gravity data found in the Netherlands East Indies and adjoining parts and the third representing the results for the West Indies found in 1926, 1928, and 1932 supplemented by a great many values on land determined by the U. S. Coast and Geodetic Survey.

The maps contain the gravity anomalies in milligal, i.e., the observed values after isostatic reduction according to the system of Hayford-Bowie,<sup>1</sup> minus the value for normal gravity as it is given by the formula of Cassinis:

$$= 978.049 (1 + 0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi)$$

The study of these results reveals two remarkable rules that appear to be fairly generally valid. These rules are:

- 1°. The positive anomalies seem inclined to occur in fields, while the negative anomalies are mostly occurring in strips; the positive fields coincide often with deep basins:
- 2°. The anomaly shows a tendency to increase, in a positive sense, when going from shallow water towards deep water; this seems to occur as well for continental coasts as for island coasts.

Instances of the second rule are found at the Atlantic end of the English Channel, near the Azores, near the southeast coast of Spain, near Suez, near Sokotra, near the Maldivé Islands, near the south coast of Ceylon, at the Atlantic side of the

<sup>1</sup>The isostatic reduction of the results has been made at the Bureau of the U. S. Coast and Geodetic Survey.

Bahamas, in the gravity profile West of Cuba, at the West coast of America between Panama and San Francisco, and in many places in the Netherlands East Indies. The basins in the Bahamas are an exception to this rule.

Instances of the first rule are found in the Netherlands East Indies, where a narrow strip of strong negative anomalies is found, bordered on both sides by fields of positive anomalies and where other strips of slighter negative anomalies can likewise be detected. The same disposition is found in the West Indies, where the Gulf of Mexico, the

Caribbean and the sea West of Cuba show positive fields while negative strips are found North of Porto Rico and Haiti, West of N. W. Cuba, near Gr. Cayman Island, near Jamaica and in the inland seas of the Bahamas. A third instance has been stated in the investigated part of the Atlantic, where an extensive field of positive anomalies was found, interrupted by strips of lesser anomalies near the Azores and in a few other places.

We shall consider these rules again at the end of this report.

### THE GRAVITY RESULTS IN THE NETHERLANDS EAST INDIES AND ADJOINING REGIONS

Because of the world-crisis the results have not yet been supplemented by gravity research on the islands but the field is already complete enough for drawing conclusions and these conclusions are important for many problems of the Earth's crust.

The results show strong deviations from isostasy of which the main feature was mentioned above: a strip of great negative anomalies (maximum  $-204$  mgal; mean about  $-100$  mgal) of a width of only 50–100 miles, running through the whole archipelago and bordered on both sides by fields of positive anomalies (maximum  $+166$  mgal, mean about  $+45$  mgal). Considered as a whole, the region is nearer to isostatic equilibrium; the mean of all the anomalies is  $+20$  mgal.

The correlation of the strip with the distribution of earthquake-centers confirms the obvious supposition that it is connected with the tectonic action in the crust. Taking this for granted, it gives a valuable indication of the course of the geosyncline, that is considered responsible for this action. It proves that the Alpine-Himalayan geosyncline, which is known to continue through Malacca and Sumatra, does not go on through New Guinea, but that it bends Northwards in the Eastern part of the Archipelago and that it continues in the Pacific geosyncline running along the east coast of Asia. It proves likewise that the Australian continent does not play the prominent part in the tectonics of this region that the supporters of the Wegener hypothesis of migrating continents think; instead of the anomalies being more intense, where the strip is bordering on this continent, as it ought to be expected in the light of this theory, they are just as pronounced where the strip is bordering on the Indian or the Pacific Oceans. If we follow the

geologists in considering this geosyncline as a region of strong lateral compression of the Earth's crust, we may draw the important conclusion that the crust under these parts of the oceans offers the same resistance to the compressional stresses as the Australian continent.

The strip shows only in a slight degree some dependence on the topography and this dependence corresponds to the second rule: the strip is mostly coinciding with a submarine ridge, while the positive fields coincide with the deeper parts. The strip shows often a correlation with the deeps but it is besides them, as it is for instance the case for the Java Deep and the Weber Deep. The fact that the anomalies for those parts of the strip that are near deeps are not stronger than for other parts, clearly indicates that deeps are not independent features, but that they are accompanying features of much greater phenomena. Gravity surveys of deeps will, therefore, have to encompass wider areas than the deeps themselves.

The fact that the strip is not coinciding with the deeps but mostly with submarine ridges, prevents explaining it by incomplete compensation of surface features. It is neither acceptable to explain them by assuming recent surface movements that are not yet compensated; the course of the strip makes this assumption unlikely as it would assume the downward pressing of the ridges. So the only explanation that is left is to assume abnormal light masses in the upper layers of the Earth.

It will, however, hardly be feasible to locate this whole mass-defect in the sialic layer, because we should then have to assume densities that are too small for being acceptable. For a great part at least we shall have to ascribe it to a protuberance

at the lower boundary of the crust of the lighter sialic layer in the denser simatic layer. In case we assume a second density-discontinuity in the crust itself, a part of the mass-defect will occur in the same way at this latter boundary.

This explanation leads to the hypothesis that the crust of the Earth of a thickness of some 25 km is buckling inwards along the axis of the strip and that only a relatively shallow upper layer is folding and overthrusting outwards and causing the irregular topography of the Archipelago. This hypothesis is in agreement with the Airy view of the isostatic balance of mountain-chains, which assumes great roots of lighter surface-material below the mountains. That these roots are only coming into existence along one axis in the present period, seems mechanically sound, as it would be difficult to understand that the crust should give way simultaneously along several lines of weakness, one behind the other.

Accepting this hypothesis, we have to realize that the crust is bulging downwards in regions where the temperature is higher. So we may safely assume that its plasticity will gradually increase and we have to expect that, at least partially, the protuberance will flow away laterally along the lower boundary of the crust. The melting and the corresponding expansion of these masses will probably bring about a rising of the mountain area and this agrees with the geomorphological facts: many mountain-chains have shown rising in the period following on the folding.

The melting and flowing away of part of the downward protuberance will also bring about a decrease of the negative anomalies and a widening of the strip. Besides this cause, there is another reason for a decrease of the deviations of isostasy in the later stages of the phenomenon, viz. the fact that the lateral movement of the crust towards the strip will automatically bring about a concentration of the surface formations over it; this tends likewise towards a reestablishment of isostasy.

So we cannot expect older ranges to have concentrated roots of the same kind as in the Netherlands East Indies and showing the same narrow strip of negative anomalies. We may, however, expect that isostasy has not been quite reestablished and that there will still be left a remnant of these anomalies. This appears to be the case; we find, after isostatic reduction, an area of negative anomalies below the Alps and a similar thing is found in the United States under the old range of the Appalachi-

ans and in other instances. In these last cases it is, however, possible that the anomaly may be explained by deviations of density in the crust itself.

The Indian Archipelago shows likewise an instance of a strip of smaller negative anomalies that is likely to be the remnant of an older folding phenomenon, i.e., a strip running over the arc of lesser Sunda Islands and continuing over the inner Banda Arc. It is possible that there are more of these strips in the western half of the Archipelago, but the lack of gravity values on the islands prevents any certainty on this point.

The geologists<sup>2</sup> have, however, found a strip of another kind in the Archipelago which merits special mention in this connection. This is a strip of strong sedimentation in recent times, which discloses some evidence of folding but no effects of strong lateral compression, as is found on the islands in the strip of strong negative anomalies (Timor, Key Islands, Ceram). This other strip is found in east Sumatra, in north Java, in S. W. Celebes and in east Borneo; it is not continuous but it is interrupted in some places. Where gravity has been determined above this strip, it shows small negative anomalies or at least smaller positive ones than those in the neighborhood. I think we may safely interpret this strip as a down-bending of the crust, without buckling, and a filling up of this trough with sediments. The negative anomalies may be explained by the smaller density of these sediments without its being necessary to assume mass-defects at the lower boundary of the crust by the replacement of denser subcrustal material by lighter crustal material. We may thus consider this as an instance of a strip of small negative anomalies, that has another meaning than a remnant of an older folding phenomenon. We may conclude that we have to be careful in interpreting these strips of smaller negative anomalies; they may point to old folding but they may likewise be explained by a thick layer of sediments which has formed in a sunken strip of the crust.

Getting back to the main feature of the gravity field, the strip of strong negative anomalies, I may mention that the root at the lower boundary of the crust must have dimensions of some 25 x 50 km in order to explain the magnitude of the anomalies. Assuming that the crust has a thickness of 25 km, the root must have a width of at least 50 km,

<sup>2</sup> "Het Neogeen in den Indischen Archipel," by Prof. Dr. J. H. F. Umbgrove; *Tydschr. Ned. Aardryksk. Genootschap*, 1932, no. 6.

according to the buckling hypothesis, and we get a shortening of the crust of about 50 km. This figure is confirmed by other considerations.

This confirmation has to do with the gravity anomalies found west of Sumatra and east of the Philippines. Here the strip has no longer the same symmetric character that it has in the middle part of its course through the Archipelago; the negative anomalies are smaller and the transition to the positive values on the ocean side is less sudden. Taking into account the character of these gravity profiles and the fact that in these parts the direction of the strip is nearly parallel to the most probable direction of the stress, S. S. E., the most likely interpretation of the phenomenon seems here to be that Sumatra and the Philippines are sliding along the line of the strip combined with a slight over-riding of the ocean-floor. This would mean that the movement is nearly parallel to the strip with only a small component perpendicular to it. The downward bending of the ocean-floor would bring about a gravity profile of the character that is mentioned above.

South of the Philippines, near the Talaud Islands, and south of Java, the direction of the strip changes and makes a greater angle with the direction of the stress; the gravity profile assumes at once another character that points to a buckling of the crust in the way we have discussed it. We found a figure for the shortening of the crust, corresponding to this buckling, of about 50 km. Now it is a remarkable coincidence that the geologists are inclined to think that Java has moved southward with regard to Sumatra and that the amount of this movement is estimated at about 40 km. It is likewise remarkable that the bathymetric curves south of the Philippines show a similar bulging towards the east of the same amount; this topography is now known in detail thanks to the expedition of the SNELLIUS under the leadership of Van Riel which has made more than 30,000 soundings in the Eastern part of the Archipelago.

These facts provide us with a welcome confirmation of the buckling hypothesis; they point at least towards a connection of the gravity field with horizontal movements of the crust. Another still stronger confirmation is given by the fact that the only islands where great overthrusting has been stated since the beginning of the Tertiary period<sup>2</sup>, are those islands that are located over the strip: Timor, Tenimber Islands, Key Islands, Ceram, Buru, and the eastern part of Celebes; the other islands over the strip are not yet known sufficiently.

These overthrustings date from the earliest part of the Miocene, which puts them about 8,000,000 years back.

It is a remarkable fact that these islands have not experienced great deformations in the more recent periods. Still it seems probable that the great tectonic phenomenon is continuing in the present period, because the earthquakes are violent and frequent and the localization of their centers indicates that it is still the same strip that is active. These facts suggest the continuation of the lateral compression of the crust without the taking part of the surface layer. It makes the impression as if the crust is pushing together under the islands and disappearing downwards, while the islands have been elevated above the region of compression, so that they are not partaking of the great deformation save some block-faulting movements that have been going on on some of these islands; this block-faulting proves that the apparent quiescence is not real and that greater phenomena are going on in deeper layers. A comparison of this hypothesis with what is known about the tectonic history of the Alps gives promising outlooks for the understanding of the mechanism of mountain-formation; I may refer here to another paper about this subject.<sup>3</sup>

Lastly I wish to mention a remarkable correlation of the course of the strip of strong negative anomalies with the distribution of volcanoes in the Archipelago. Nearly every curve of the strip is accompanied on the inner side by a parallel row of volcanoes at a distance of a few hundred kilometers. This correlation appears to be in harmony with the buckling hypothesis, which makes it understandable that the crust, when moving towards the strip from the inner side of a curved part, is subject to tensile stresses in a sense parallel to the strip. That this circumstance will facilitate the formation of volcanoes, seems acceptable.

Examining the fields of positive anomalies in the Archipelago, we see that there are three fields of especially strong anomalies and these fields coincide with three deep basins, the Celebes Sea, the N. W. Banda Sea, south of the Sula Islands, and the Banda Sea, west of the inner Banda Arc. With the exception of the typical troughs, all other parts of the seas in the Archipelago are less deep. These basins show all the same morphological type, a smooth and even bottom and steep sides.

Taking the evidence together, we get the im-

<sup>3</sup> The Mechanism of Mountain-Formation in Geosynclinal Belts, by F. A. Vening Meinesz, Proc. Amsterdam Acad. Sc. Vol. XXXVI, No. 4, 1933.

pression that we have to do here with three areas, where the Earth's crust has been subject to an increase of density and that this is the cause of the positive gravity anomalies as well as of their sinking away. Apparently this sinking has not continued so far that the isostatic equilibrium has been completely reestablished. This view is hypothetical

and the cause of the supposed density increase is still more so. It is obvious to bring it in connection with the great lateral stresses that have been assumed in the Archipelago, but whether we can explain it exclusively by elastic compression of the crust or whether we have to assume also changes of state or temperature, seems as yet impossible to decide.

## THE GRAVITY RESULTS IN THE WEST INDIES AND ADJOINING REGIONS

Geologically speaking, the West Indies are similar to the East Indies. They are likewise tectonically active and the morphological properties of both regions show much resemblance: island rows of mountainous character, separated by deep basins, and great volcanic activity. The tectonical character is in both cases of the geosyncline type.

We need not be surprised, therefore, that the gravity results of the West Indies show many points of resemblance to the results of the East Indies. The Gulf of Mexico, the Caribbean and the sea west of Cuba show positive anomalies in the same way as the deep basins of the East Indies. The same remarks may be made concerning them.

North of Porto Rico, north of Haiti and near Windward Passage a similar strip of strong negative anomalies was found as that which has been discussed for the East Indies. The continuation of this strip to the westward is still uncertain. It is possible that the negative values obtained in the Bahamas, although less intense and not concentrated in a narrow strip, may be considered as such, but the most probable interpretation of the data seems to be that the critical zone continues along the Bartlett Deep and that, for this part of the strip, the relative movement of the two parts of the crust is nearly parallel to it. In this way there would be no compression perpendicular to the direction of the trough and it might even be that there is a small component of the relative movement of both crustal parts away from each other. This would explain the deep as a rift-formation in contrast to most other deeps, which, from the point of view of the buckling hypothesis, have to be considered as compressional features, revealing the downward movement of the crust in the buckling zone. This explanation of the Bartlett Deep is in harmony with the irregular submarine topography, suggesting sunken blocks.<sup>4</sup> It is likewise in agreement with the gravity field, which shows irregular

and not very intensive anomalies over the Bartlett Deep. There is no clear evidence of a narrow strip of negative anomalies, as has been found near all the East Indian deeps and over the Nares Deep north of Porto Rico.

The gravity profile over the strip north of Porto Rico is nearly identical with the profiles over the strip south of Java; the horizontal dimensions as well as the difference between the negative anomalies in the axis of the strip and the positive anomalies beside it are about the same. This suggests a similarity of both phenomena.

This suggestion is further confirmed by the fact that the more westward profile, the gravity profile over Windward Passage, shows much resemblance to the profiles west of Sumatra, i.e., the negative anomalies in the strip are less and the transition to the positive anomalies on the Atlantic side is more gradual than north of Porto Rico. In the same way as for the strip west of Sumatra we have here that the most probable direction of the relative movement, E. N. E., is nearly parallel to the strip and this suggests the same explanation of this changed gravity profile: no buckling but an overriding of the northern block by the southern block because of a small component of the relative movement perpendicular to the strip. If the above explanation of the Bartlett Deep is right, this component gets zero and changes sign where, still further westward, the strip gets again another direction.

The gravity field in the Bahamas merits a short discussion. The whole area shows negative anomalies but the deep basins are stronger negative than the islands. In this regard this region is one of the few exceptions to the second rule; the anomaly does not increase, in a positive sense, when going from shallow water to deep water but we find the reverse. The most probable interpretation seems to be that we have to do here with a stiff crustal block that has been sinking away and on which the islands have been elevated by the coral-reef-builders;

<sup>4</sup> This agrees with the views of Taber expressed in several of his publications.

according to this view the islands are surface loads on the crust, that are not in local isostatic compensation and so the gravity on the islands is greater than over the neighboring basins.

For further details of the gravity results in the West Indies I may refer to the publications of the two expeditions of the U. S. Navy, that have been mentioned in the introduction.

The four gravity profiles that have been made, perpendicular to the coast, between Panama and San Francisco all show rather strong positive anomalies over the foot of the shelf and about normal gravity over its top. In two instances this profile can be continued in the continent, in Mexico and near San Francisco. In Mexico this continuation shows fairly strong negative anomalies in a strip parallel to the coast and so we get the impression that we have here another instance of the same feature: a strip of negative anomalies bordered on both sides by positive anomalies. The profiles perpendicular to the coast look as if they are the outer parts of profiles over this strip. The correlation with the earthquake activity appears to confirm this view. More research will be necessary before we can be sure about it and before we know if this strip is the continuation of the critical zone in the West Indies, which appears to continue through the Bartlett Trough.

The second profile, over San Francisco, confirms our supposition up to a certain degree, but the strip is less intense than those in the East and West Indies. The greatest negative value, found outside the coast, is only  $-57$  mgal. Another deviation of this gravity profile from the normal profile in the Indies is, that the anomaly remains slightly negative in the U. S. up to a great distance from the coast, instead of showing the positive values found elsewhere besides the strips.

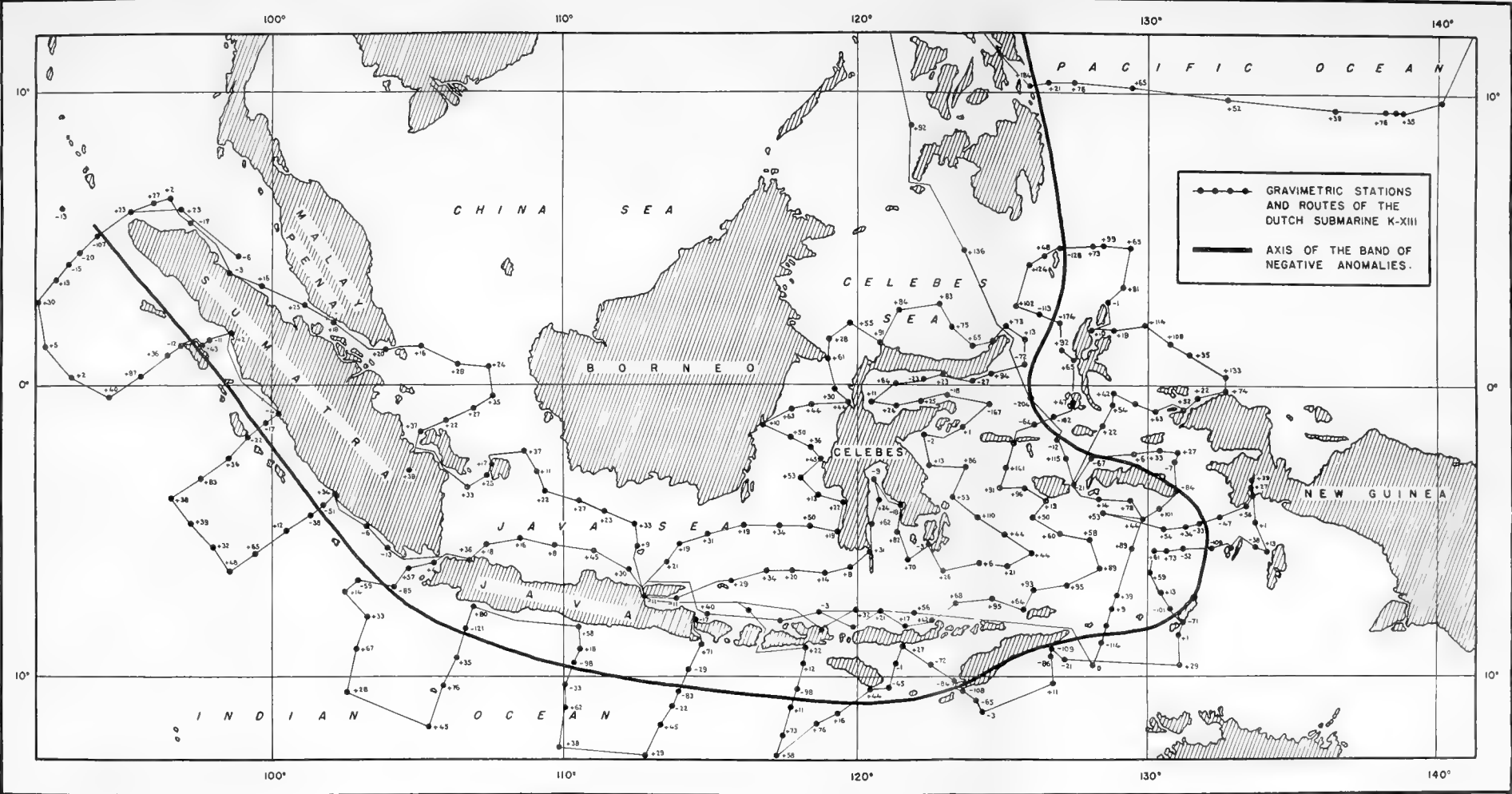
After this more detailed discussion of two regions, we may shortly consider again the two general rules mentioned in the beginning. We found both rules valid in the East and West Indies and we have discussed a hypothesis about what is going on in these parts. If this hypothesis is true we have to do with a buckling towards the inside of the Earth's crust along a curved line and this buckling brings

about a thickening of the crust along this line. This is accompanied with strong negative anomalies because of the accumulation of light crustal material and in most parts with a submarine ridge because of the outward bulging of the surface layer. We find thus both rules realized by this phenomenon: the coming into existence of strips of negative anomalies and a tendency of the anomaly to increase, in a positive sense, when going from smaller to greater depths.

We have further found that the deep basins in the East and West Indies show positive anomalies and this is also in harmony with the two rules. A well-founded explanation of these positive anomalies is still lacking, but there seems to be little doubt that there is some connection with the tectonic phenomena in these regions.

We are now confronted with the important question whether the other instances, where these rules have been found valid, can also be explained in the same way, or, in other words, whether all these instances can be considered to be related to the same tectonic phenomena, active or extinct, that are going on the East and West Indies. Or are there other phenomena, bringing about similar results for the gravity field?

This important question cannot yet be answered; future research will have to provide the data for attacking this problem. As far as the gravity research is concerned, the following program seems indicated. First the further investigation of tectonically active areas for the elucidation of the great geophysical problems of these regions. Secondly the investigation of the distribution over the Earth's surface of the fields of positive anomalies, that occur in some regions, e.g., in the Atlantic and, though less intense, in the Pacific, in order to see if they are of the same kind as the fields of positive anomalies in the deep basins of the East and West Indies. Thirdly, the investigation of the gravity transition for all steep submarine slopes, e.g. near continental shelves and near island coasts. This further research may provide us with important possibilities for the investigation of the Earth's crust under the oceans.









## SUPPLEMENTAL STATEMENT

PLATES 35, 36

Since the foregoing paper by Professor Vening Meinesz could not be promptly published after he submitted his manuscript, a supplement is needed. The notes that follow do not claim to be exhaustive but they indicate the activity in gravity determinations at sea by five different countries. The fundamental significance of such research is forcefully presented by Vening Meinesz in the first publication by him cited below.

After his manuscript was prepared Vening Meinesz himself made a voyage in 1935 on a submarine

Vening Meinesz, F. A., with collaboration of Umbgrove, J. H. F., and Kuenen, Ph.H., Report of the gravity expedition in the Atlantic of 1932, and the interpretation of the results: Gravity Expeditions at Sea, 1923-1932, vol. 2, pp. 208, 4 pls., text figs., 1934. (Publication of Netherl. Geod. Com.)

Vening Meinesz, F. A., Interpretation of the anomalies of gravity: Hydrogr. Review, vol. 14, no. 1, pp. 107-108, May, 1937. (Translated from the French, reproduced from an article published in Bulletin Gèodésique, no. 46, Paris, 1935.)

Vening Meinesz, F. A., The gravity expedition of Hr. Ms. Submarine O 16 in the north Atlantic, January

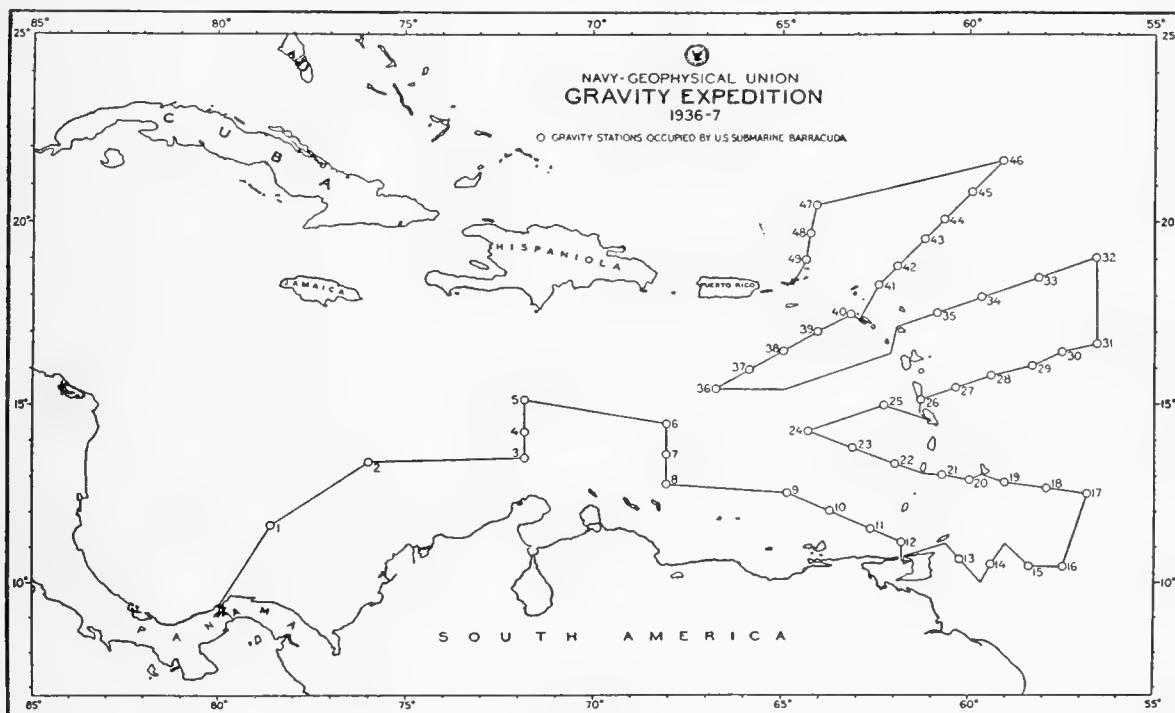


FIG. 9

from the Netherlands across the Atlantic to Rio de Janeiro and thence by the Cape of Good Hope and Australia to the East Indies, and in the early months of 1937 he made another voyage across the Atlantic, from the Netherlands by way of the Azores to Chesapeake Bay, and he returned by a more northerly route. Except the indicated itinerary other information on these voyages is not yet available.

Three publications by Vening Meinesz, one in collaboration with Umbgrove and Kuenen are as follows:

11-March 16, 1937: Konink. Akad. Wetensch. Amsterdam, Proc. vol. 40, no. 5, pp. 382-388, 1 chart, 1937.

The chart illustrating the route is reproduced as plate 36.

It would be interesting to insert here the interpretations of the results procured by Professor Vening Meinesz and his associates but that is not now practicable.

During the winter of 1936-37 there was an expedition on the U. S. Naval Submarine BARACUDA to the West Indies. A note on this expedition is

contained in the following paper by Capt. H. E. Kays:

Kays, H. E., The oceanographic work of the Hydrographic Office and the United States Navy from

expedition to the West Indies." The route and the stations occupied are illustrated by fig. 5, here reproduced as fig. 9 of this work.)

At the same meeting of the American Geophysical

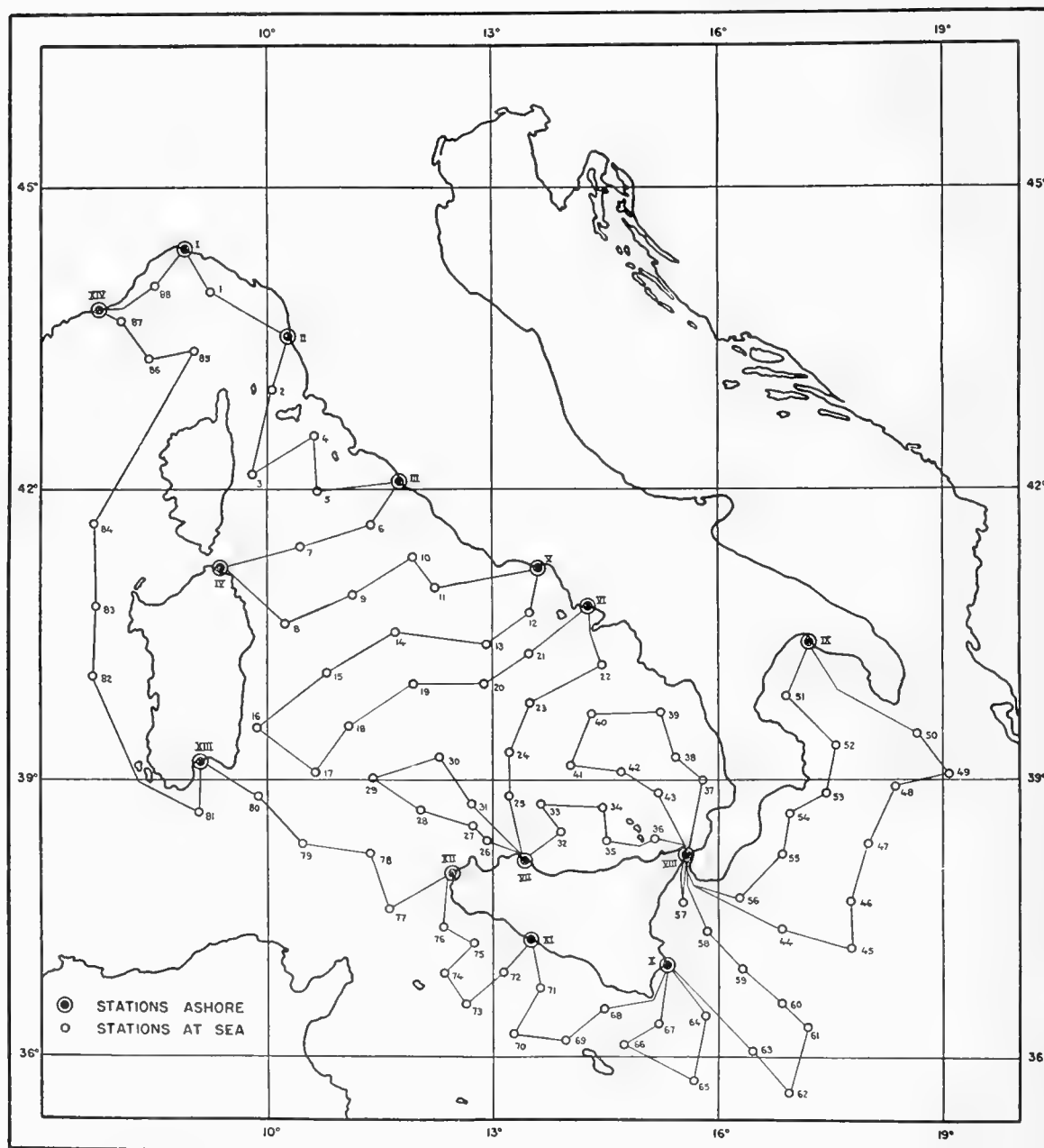


CHART SHOWING THE GRAVIMETRIC STATIONS OCCUPIED BY THE ITALIAN SUBMARINE VETTOR PISANI.

Fig. 10

April, 1936, to April, 1937: Amer. Geophys. Union, 17th Ann. Meeting 1937, Trans., pp. 194-201. (One section of this report is entitled "Gravimetric

Union the following papers which will be published in the Transactions of the meeting, were also presented:

Ewing, Maurice, Gravity measurements on the U. S. S. BARACUDA.

Hess, Harry H., Geological interpretation of results of the cruise of the U. S. S. BARACUDA—a preliminary report.

The Italians have been active in studies of gravity at sea. References to their work are as follows:

L. T. (L. Tonta), Short note on the measurement of the acceleration of gravity at sea and on an Italian gravimetric cruise in the Tyrrhenian Sea: *Hydrogr. Review*, vol. 8, pp. 243-248, 1931.

Cassinis, G., An Italian gravimetric cruise in the Mediterranean: *Hydrogr. Review*, vol. 9, pp. 148-149, 1 fig., 1932.

Cassinis, G., I risultati della crociera gravimetrica del R. Sommergibile VERTOR PISANI e la gravità in Italia: *Soc. Ital. Progr. Scienze*, 22 Riun., Bari, Oct. 1933, *Atti*, vol. 2, 1933. *Abstr.*, *Hydrogr. Review*, vol. 11, pp. 185-186, 1934.

Figure 10 shows the route of the vessel and the positions of the stations occupied.

The French have also done some work in the Mediterranean. A note on their expeditions is contained in the following article:

Cot, D., *L'Étude de la pesanteur sur la mer*: Assoc.

internat. d'Océanogr. phys., Gen. Assemb., Edinburgh, Sept. 1936, *Proc.-Verb.*, no. 2, pp. 163-164, 1937. (Note on cruises of the French Navy in the Mediterranean in 1933 and 1936.)

The Japanese for several years have been active in the study of gravity at sea over the Nippon Trench and adjacent areas. References to three publications are as follows:

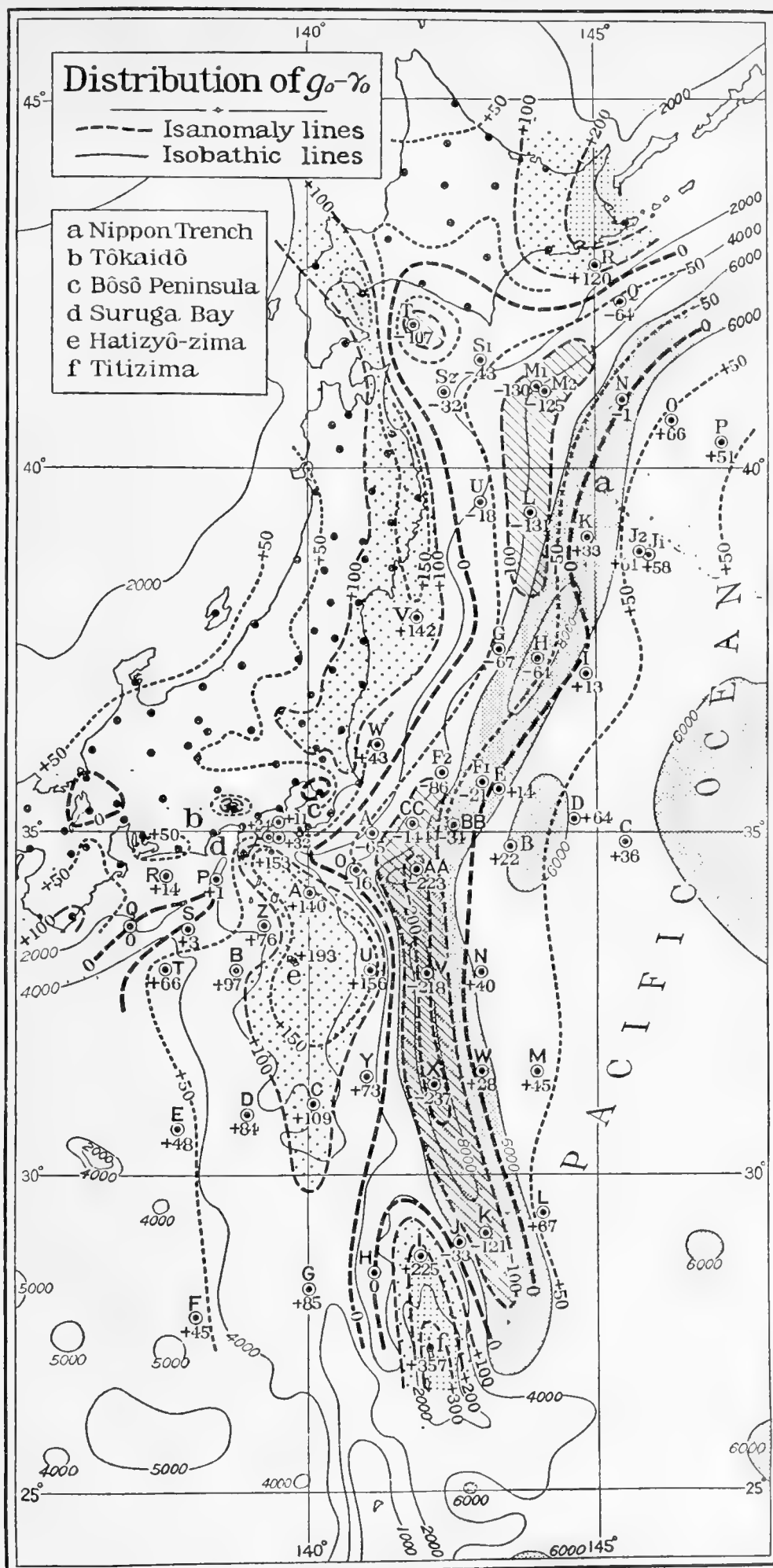
Matuyama, M., Measurements of gravity over the Nippon Trench on board the I. J. Submarine RO-57, preliminary report: *Imper. Acad. Proc.*, vol. 10, pp. 626-628, 1934.

Matuyama, M., Distribution of gravity over the Nippon Trench and related areas: *Ibid.*, vol. 12, pp. 93-95, 1 fig., 1936.

Matuyama, M., Gravity survey by the Japanese Geodetic Commission since 1932: *Internat. Union Geod. and Geophys.*, Sixth Gen. Assemb., Edinburgh, 1936, *Japan Nat. Com. Geod. and Geophys. Rept.* no. 2, pp. 8, 1 fig., 1936.

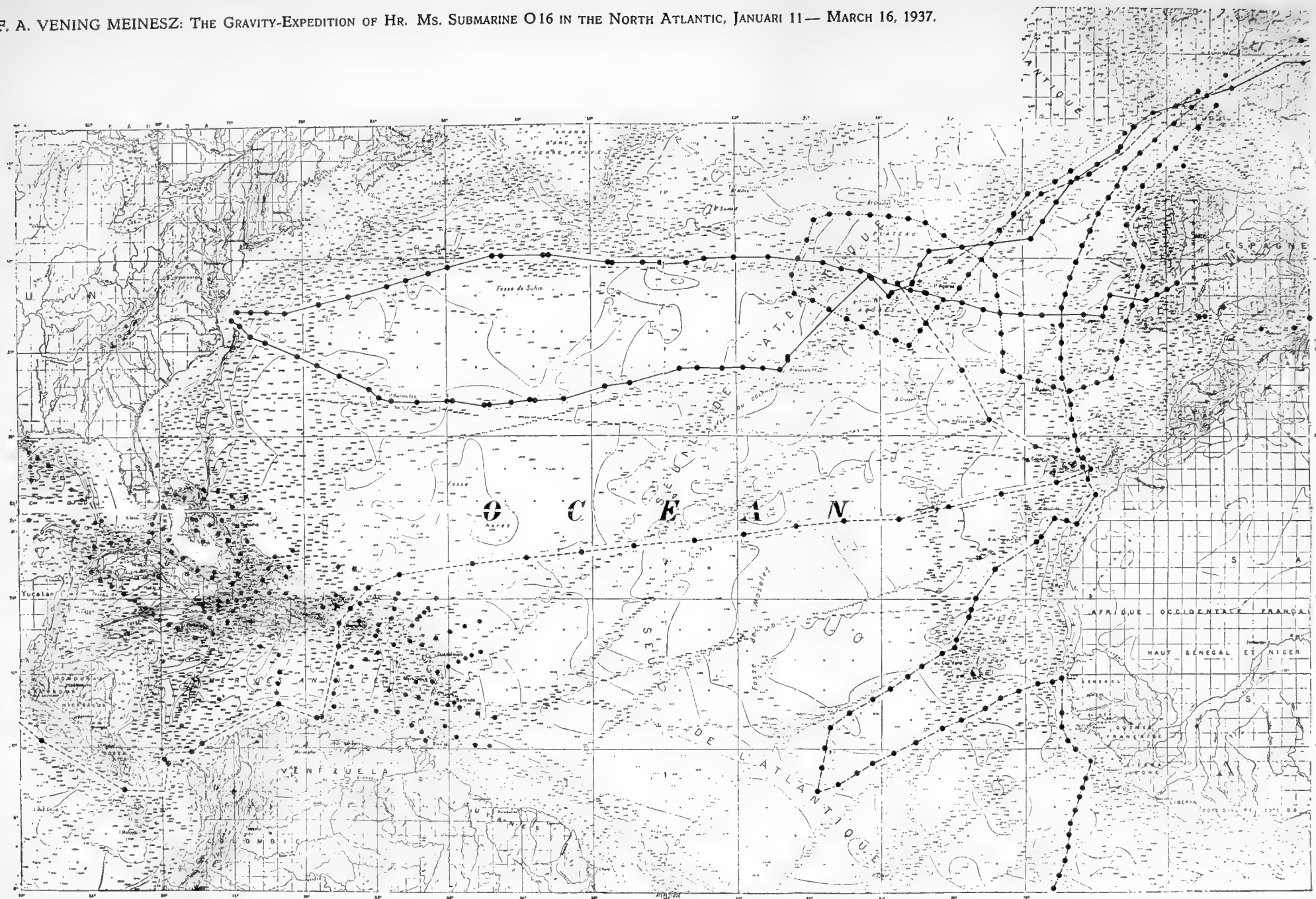
Plate 35 is a reproduction of the chart presented in the third paper by Professor Matuyama. This chart is interesting in that it shows a distribution of gravity anomalies similar to those that have been discovered in both the East and the West Indies







## F. A. VENING MEINESZ: THE GRAVITY-EXPEDITION OF HR. MS. SUBMARINE O 16 IN THE NORTH ATLANTIC, JANUARI 11—MARCH 16, 1937.



Proceedings Royal Acad. Amsterdam, Vol. XL, 1937.

THE ROUTE OF H. M. SUBMARINE O16 IN THE NORTH ATLANTIC IS INDICATED BY A FULL LINE. THE ROUTES OF FORMER EXPEDITIONS H. M. K. XIII, O. XIII, AND K. XVIII BY DOTTED LINES. THE FEW STATIONS NEAR EUROPE OBTAINED WITH H. M. K. II AND K. XI ARE HAD BEEN ADDED. THE STATIONS BY THREE EXPEDITIONS OF THE UNITED STATES NAVY IN THE WEST INDIES AND ADJOINING WATERS BY U. S. S. S-21, S-48, AND THE BARACUDA HAVE ALSO BEEN PUT ON THE CHART



**CATALOGUE OF INSTITUTIONS ENGAGED IN  
OCEANOGRAPHIC WORK**



# GENERAL DISCUSSION

## PREVIOUS CATALOGUES

In 1910 Charles Atwood Kofoed published a volume entitled "The Biological Stations of Europe,"<sup>1</sup> in which accounts are given of both the marine and fresh water biological laboratories and also the stations for fish culture in Europe. A number of the institutions, of which Kofoed gives accounts, are included in the present volume but in the twenty-seven years that have elapsed since Kofoed's book was published there have been many changes. Some of the stations have undergone great development, while others have been abandoned. Although it might be interesting to compare conditions in 1910 with those at present it does not seem necessary to do so. A succinct history is given in the present catalogue of each station for which information could be procured. Those who wish to do so may make the comparison. One feature of Kofoed's book is an extensive bibliography of earlier publications dealing with the European stations.

In 1927 Prof. G. Magrini published a catalogue entitled "Instituts et Laboratoires s'occupant de l'étude de la mer." (Édition provisoire.)<sup>2</sup> This catalogue is preceded by another entitled "Liste des océanographes des pays adhérents à l'Union." (2e Édition)<sup>3</sup> Another catalogue is that of the marine stations of the Pacific.<sup>4</sup> Accounts of several important oceanographic institutions are included in the two volumes *Forschungsinstitute; ihre Geschichte, Organisation, und Ziele* edited by Brauer, Ludolph, and others.<sup>5</sup> Numerous magazines carry accounts of institutions. One of them is the *Collecting Net*, published by Ware Cattell, during the summer months at Woods Hole, Massachusetts. The *Year Book* issued by the International Hydrographic Bureau at Monte Carlo gives an up-to-date list for each year of the hydrographic services for all countries and constitutes a valuable book of reference.

## METHOD OF PROCURING INFORMATION AND DATES OF ITS VALIDITY

The journey that the author of this volume made around the world has been mentioned in the preface. While on the journey, conferences were held in each country with those who were believed to be the best informed regarding oceanographic institutions in that country. With the help of these advisers lists were made for each country of the institutions on which information was desired. Some information was obtained on the ground by visits to many institutions but the chief dependence was put upon the replies to questions that were sent to each institution. It has already been stated that the responses to requests for information were most gratifying. The accounts as given can for nearly all institutions be credited to the chief officer of the institution. For such countries thanks are here expressed to all who helped assemble information. For some countries, as has already been stated, an individual undertook to obtain the various accounts for his

country. A list of those who rendered such assistance has already been given.

The information as first assembled was of the date of about January 1, 1934, but, as has been stated, the manuscript of the report could not be completed at the expected time. Therefore it was necessary to get the information as nearly as possible as of the date of January, 1937. In the catalogue of the institutions, after the name of the institution, the date of the information has been given, usually as '34 or '37. It will be seen that answers were received from nearly all requests for revisions. Only a few of those to whom inquiries were ad-

<sup>2</sup> Cons. Internat. Rech., Union Géodés. et Géophys. Internat., Sect. d'Océanogr., Bull. no. 7, pp. 115, 1927.

<sup>3</sup> *Ibid.*, Bull. no. 6a (1 re livraison) (Afrique du Sud, Algérie, Australie, Bahamas, Birmanie, Canada, Égypte, Espagne, France) pp. 33, 1925; Bull. no. 6b (2ième livraison) (États Unis, Grande Bretagne, Italie), pp. 67, 1927.

<sup>4</sup> Vaughan, T. W., Catalogue of marine stations of the Pacific, in International Committee on the Oceanography of the Pacific—report of the Chairman: Fifth Pacific Sci. Congr. Proc., vol. 1, pp. 361-380, 1934.

<sup>5</sup> Hamburg, 1930.

<sup>1</sup> United States Bureau of Education, Bull. whole number 440, pp. XIII, 360, 55 pls., 48 text figures, Washington Government Printing Office, 1910.

dressed failed to respond, and these may be excused on the probability of the requests not having reached them or because no revisions of statements already submitted were needed. A very few of the records are taken from the list of Professor Magrini ('27) cited above. Regarding the institutions in Spain, it should be said that Prof. Rafael de Buen

helped to get accurate records of the Spanish institutions for about the summer of 1934—they were probably accurate to the end of 1934. Because of the distressing civil war in Spain the records have been left as they were submitted by Professor de Buen. It is not possible to forecast what the conditions will be after the war is ended.

## OCEANOGRAPHIC RESEARCH OUTSIDE OCEANOGRAPHIC INSTITUTIONS

Although the account of oceanographic institutions is intended to give a picture of the researches conducted by them it does not cover all the important oceanographic work, for example, Prof. V. Bjerknes, the father of modern dynamical oceanography, is connected with the Department of Physics at the University of Oslo and is now not a member of the staff of any oceanographic institution, although he was at one time connected with the Geophysical Institute at Bergen, Norway. Prof. Johan Hjort and his assistants are preparing reports on oceanographic collections in the biological laboratory of the University of Oslo. Prof. H. H. Gran is the head of the botanical institute in the same university. Prof. V. W. Ekman, another leader in dynamical oceanography, is professor of hydrodynamics at the University of Lund. The names of others might be mentioned.

It was desirable to include in this report a catalogue of oceanographers, but that was not practicable. The list of oceanographers prepared by Professor Magrini has been mentioned. For those who care to do so an extensive but incomplete list of the research workers in oceanography can be compiled by taking from this report the names of those who are members of the staffs of the different

institutions and the names of others who are mentioned in the discussion of various topics.

Much valuable oceanographic research is done at institutions in which such investigations are only incidental to other activities. An instance of this is the investigation of the various aspects of marine bottom deposits at the United States Geological Survey. An investigation now under way at it is the study of the bottom cores obtained in the northern Atlantic by the use of the Piggot gun mentioned at another place in this report. Many museums conduct, on collections, sent them, researches that are of great value to oceanography. In general these museums are not listed in this catalogue, but a few will be mentioned here. The British Museum of Natural History conducts investigations on collections obtained by oceanographic expeditions and it is not restricting its researches to biological material. Recently Dr. J. D. H. Wiseman has been appointed a member of the staff of the Mineralogy Department and he will work on marine bottom deposits. Another museum at which valuable work is done is the one at Hamburg. Nearly all of the large museums, that serve as depositories of oceanographic collections, make by the researches of the members of their staffs valuable contributions to oceanography.

## ACTIVITIES BY COUNTRIES

The catalogue here presented contains the names of 245 institutions, after eliminating the *POURQUOI PAS?* which was destroyed in September, 1936. It is probable the names of a few inactive or abandoned institutions, names taken from Magrini, 1927, are included, and it is also probable that there have been some omissions, but it is believed that a fair picture is given of the provisions for work on the various aspects of the oceans in the different countries. The distribution of the institutions by countries is indicated by the following table, but it

does not necessarily follow that the oceanographic output of a country can be inferred from the number of institutions or marine stations in it. In some countries the work is concentrated. In Germany, for example, instead of there being a number of marine biological stations, as in France, the United States, and Japan, there is one large excellently equipped station on Helgoland. A large number of small stations helps the students of many universities to get access to the sea and its inhabitants. France has large stations as at Roscoff and Arago

*Distribution by Countries of Institutions Engaged  
in Oceanographic Work*

COUNTRY	NUMBER
International.....	9
Algeria.....	2
Belgium.....	2
Czechoslovakia.....	2
Denmark.....	3
Egypt.....	3
England.....	10
Estonia.....	1
Finland.....	4
France.....	17
Germany.....	8
Greece.....	2
Hungary.....	1
Iceland.....	1
Ireland.....	1
Italy.....	15
Latvia.....	2
Lithuania.....	1
Monaco.....	1
Netherlands.....	3
Norway.....	8
Poland.....	1
Portugal.....	2
Rumania.....	2
Scotland.....	3
Spain.....	9
Sweden.....	7
Tunis.....	1
Turkey.....	1
Union of South Africa.....	4
Yugoslavia.....	2
U. S. S. R. (west part).....	13
(Siberia).....	2
Bermuda.....	1
Canada (east).....	5
(west).....	2
Newfoundland.....	1
United States (east).....	20
(west).....	12
Argentina.....	2
Brazil.....	2
Uruguay.....	2
Chile.....	2
Ecuador.....	1
Peru.....	4
Australia.....	5
China.....	5
French Indo-China.....	1
Hong Kong.....	1
Japan.....	18
Neth. East Indies.....	2
New Zealand.....	1
Philippine Islands.....	5
Siam.....	1
Straits Settlements.....	1
India.....	8

de Banyul sur Mer, as well as small stations. Several countries that have relatively few institutions, as Denmark, Finland, Norway, and Sweden, are among the leaders of the world in oceanographic research.

Attention should be called to the paucity of oceanographic stations south of the Equator. In South Africa there is one and there soon will be two, in Java one, in Australia one, in New Zealand one, and on the east coast of South America perhaps two of three fishery stations. With reference to the tropics, including the stations both north and south of the Equator, there are the stations in India which are mostly for fishery research, one in Java, one in the Philippines at Puerto Galera, one in French Indo-China, the Palao station of the Japanese, and the station at Wakaiki, Oahu, Hawaiian Islands. The station at Tortugas, Florida, of the Carnegie Institution of Washington, falls just outside the northern limit of the tropics, while the Bermuda station is still farther north but semi-tropical. The station at Ghardaqa in the Red Sea is also semi-tropical, although it is considerably north of the Tropic of Cancer. The number of accessible, well equipped stations is very small and at present they are all principally for marine biology—other aspects of oceanography receive either no or only secondary attention. An endeavor should be made to establish on some island within the high tropics a research station both for marine biology and other aspects of oceanography. Several of the stations are well situated except for accessibility. This is true of the station at Puerto Galera in the Philippines and that of the Japanese in the Palao Islands. Information has been obtained on the suitability of a number of places in the Pacific. The sites that seem to merit most consideration are the Island of Tahiti, and some island of the Samoan or Fiji group. All of these islands are on major trans-Pacific steamship routes and offer opportunity for the study of a wide range of oceanographic problems. There should also be a station on some island in the West Indies. The station at Bermuda is outside the tropics; the one at Tortugas, Florida, is more tropical but it is not easily accessible and it is in operation only a part of the year. There are good sites in the Virgin Islands, on the Island of Jamaica, and probably on other islands that are regularly visited by passenger vessels.

## FUNDS AVAILABLE FOR OCEANOGRAPHIC RESEARCH

One of the questions on the requests for information was "Income—Source—Amount," for the purpose of ascertaining how much was being expended in each country on oceanographic work. For many institutions the desired data were given, but for others the question was not answered. Since the data are inadequate for a satisfactory statistical study of the matter, only a few comments will be made.

A discouraging fact is that some important institutions are in financial difficulties. This is true of the Institut Océanographique, including the

Musée Océanographique, founded by H. S. H. Prince Albert I of Monaco, and of the Stazione Zoologica of Naples. It is probable that the achievements in Spain have been nullified by the devastating civil war in that unhappy country. In some countries, particularly Japan and the United States, there has been great progress within the past ten years. In each of them oceanographic research was backward, but they are now among the leaders. Much interesting information is contained in the records here given, but it is not suited to statistical treatment.

# ANALYSIS OF THE ACTIVITIES OF THE INSTITUTIONS ACCORDING TO SUBJECT

The activities of the institutions engaged in oceanographic work have been tabulated according to fourteen topical headings. Only short notes will be made on each of the topics, except "instruction" of which there will be succinct but fuller discussion.

*Seismology.* Although seismological research is not prosecuted at any of the institutions here considered, except the United States Coast and Geodetic Survey, many stations have seismographs installed on their premises and they coöperate with seismological specialists. The vital importance of seismology for oceanography is shown by the article contributed to this volume by Professor Gutenberg.

*Hydrographic surveys.* Each important country has a hydrographic service usually attached to its navy. The United States divides its hydrographic work between two organizations, the Navy, for foreign waters and the high seas, and the Coast and Geodetic Survey, for home waters. The hydrographic services of several countries are among the foremost contributors to oceanographic knowledge.

*Tidal records and research.* The note on Tides by Mr. H. A. Marmer in this report gives a picture of tidal research. Automatically recording tide gages are installed at many marine stations, but tidal research is prosecuted at very few. Among those that are active are the Liverpool Observatory and Tidal Institute, England, the Institut für Meereskunde, Berlin, Germany, the Geophysical Institute at Bergen, Norway, the Bornö Station, Sweden, and the Thalassological Institute of Finland. Tidal experts are connected with most of the larger hydrographic services, and some of them conduct researches on problems of tidal theory.

*Records of temperature and salinity.* Records of temperature are kept at many, probably nearly all, marine stations for at least a part of the year, and at some for the entire year. The determination of the salinity of the water is not so general. The fully equipped oceanographic institutions conduct systematic studies of temperature and salinity over the entire field of their operations. It is probable that more work is indicated in the table than is actually done, but accuracy was not practicable.

*Physics.* Most of the work on the physical properties of sea water is of a very simple kind, such as the depth of the visibility of a Secchi disc, but at some institutions the researches are of excellent quality. Among the subjects investigated are the depth of penetration of radiant energy, evaporation, convection, heat conduction and diffusion, and the content of radioactive substances—a subject that is both physics and chemistry.

*Chemistry.* Because of the biological significance of many chemical features of seawater, routine chemical determinations and some actual research are conducted at many stations. Much of the chemical work has applications to other aspects of oceanography, for example, to studies of circulation and to geological problems.

*Dynamical oceanography.* Although water movements are observed and recorded more or less qualitatively at many places and although numerous institutions are building up bodies of data necessary for the study of the dynamics of water masses, researches on the principles and the application of the principles of modern dynamical oceanography are prosecuted at relatively few institutions. The training of a larger number of young people in dynamical oceanography is one of the needs of the science.

*Sediments.* Marine bottom samples are collected by a number of institutions and several others serve as depositories, but actual research is conducted at only a few places. This subject is further discussed on page 35 of this report.

*Meteorology.* Observations are recorded at many places, and a number of institutions are repositories of data, which are compiled, averaged, and plotted, but there is far too little fundamental research. Investigations in marine meteorology involve researches in physics, also included under that caption.

*Gravity at sea.* Since the determination of gravity at sea depends upon having submarines available for the requisite cruises, such work is necessarily in conjunction with the Navy departments of interested countries. The leader in this work is the Netherlands. Other countries that have been active are France, Italy, Japan, and the United

States. (See article by Prof. F. A. Vening Meinesz, this report page 59.)

*Terrestrial magnetism.* Observations to aid navigation are made by most hydrographic services, but research has been very restricted. (See article by Dr. J. A. Fleming, this report, page 50.)

*Fisheries.* Except general marine biology, the provisions for fishery investigations exceed those for any other kind of oceanographic work. Nearly every country of importance has either a separate fishery service, or fishery research is assigned as a function to an institution of broader oceanographic scope, for example, the Institut océanographique de l'Indochine. In some countries, such as the United States, subordinate political subdivisions support special services, for example, the State of California. It is probable that some of the subordinate fishery services have not been included in this catalogue.

*Marine biology.* There is in this volume no special discussion of marine biology. The amount of attention paid the subject is shown in the table of institutions engaged in oceanographic work. More attention is given marine biology than to any other aspect of the sea. The investigation of the marine

environments has lagged behind the study of the organisms that live in those environments. References are given in the footnote below<sup>1</sup> to two symposia, of which most of the papers are here pertinent. The purport of the one by the compiler of this volume is obvious from its title. The article is based on a study of the programs of the leading marine biological stations of the world.

<sup>1</sup> *Ecolog. Mon.*, vol. 4, no. 4, pp. 421-554, 1934.

Conditions of Existence of Aquatic Animals, Symposium at the Century of Progress Exposition, Chicago, Illinois, June 22, 1933:

Conditions of life in the ocean, August Krogh.

Conditions of life at great depths in the ocean, August Krogh.

Particulate and dissolved organic matter in inland lakes, E. A. Birge and C. Juday.

Ecology of lake fishes, A. S. Pearse.

The biochemistry of the invertebrates of the sea, Paul S. Galtsoff.

Faith in the results of controlled laboratory experiments as applied in nature, V. E. Shelford.

Oceanography, Symposium, Boston, Massachusetts, December 30, 1933:

Present trends in the investigation of the relations of marine organisms to their environment, T. Wayland Vaughan.

The distribution and conditions of existence of bacteria in the sea, Selman A. Wakman.

Factors affecting the vertical distribution of copepods, George L. Clarke.

Concerning the organization of marine communities, W. C. Allee.

## INSTRUCTION IN OCEANOGRAPHY

This catalogue of institutions was intended to make records of those institutions engaged in oceanographic activities other than instruction, but as instruction is a part of the programs of many, it has been indicated both in the statements regarding the institutions and in the table. Leaving out those institutions that are concerned only with biological subjects, a list of the institutions in the table that give instruction in oceanography, its physical and chemical aspects, with variable emphasis on its biological aspects are as follows:

Czechoslovakia: Prague, Geographical Institute, Charles University.

England: Hull, Department of Zoology and Oceanography, University College, Hull. Liverpool, Department of Oceanography, University of Liverpool.

France: Paris, Institut Océanographique.

Germany: Berlin, Institut für Meereskunde.

Kiel, Universität, Meereschemisches Laboratorium and Meeresgeologische Forschungsstelle.

Italy: Naples, Gabinetto di Oceanografia e Meteorologia, Università di Napoli.

Norway: Bergen, Det Geofysiske Institutt.

Sweden: Göteborg, Oceanografiska Institutionen vid Göteborgs Högskola.

United States: Cambridge, Mass., Department of Oceanography, M. C. Z., Harvard University.

La Jolla, Calif., Scripps Institution of Oceanography, University of California.

Pacific Grove, Hopkins Marine Station, Stanford University.

Seattle, Wash., Oceanographic Laboratories, University of Washington.

Japan: Kyoto, Institute of Physical Oceanography, Imperial University of Kyoto.

Tokyo, Imperial Fisheries Institute.

Special instruction in hydrographic surveying and allied subjects is given to naval officers by several of the hydrographic services of important countries.

The foregoing tabulation and note do not represent all available instruction in oceanography. Supplements are as follows:

Norway: Oslo, Institute of Geography, University of Oslo, Professor Werner Werenskiöld conducts the course. A volume by him is mentioned below.<sup>2</sup>

Prof. V. Bjerknes at Oslo gives no courses but is available for conferences.

<sup>2</sup> Werenskiöld, Werner, *Fysisk Geografi, I. Geofysik, Meteorologi, Oceanografi*: H. Aschehoug and Co., Oslo, 1925, Oceanografi, pp. 244-340.

Germany: Hamburg, Universität. Excellent and comprehensive instruction in "Physik and Chemie des Meerwassers" is given by Prof. B. Schulz and associates.

Netherlands: Utrecht, University, a course in physical oceanography every other year by Prof. E. van Everdingen, Jr., and some lectures by Prof. K. Oestreich, the head of Geographical Institute. At Amsterdam lectures are given by Prof. W. van Bemmelen.

Sweden: Lund, University. Prof. V. W. Ekman gives no courses in oceanography but he is available for conferences.

United States: Cambridge, Mass., Massachusetts Institute of Technology. Instruction in physical oceanography is offered by Prof. C-G. Rossby and Mr. C. O. Iselin II.

New York, Columbia University provides extension courses in oceanography by Mr. V. P. de Smitt as a part of the geographical program.

Japan: Tokyo, College of Agriculture and Forestry, Tokyo Imperial University, instruction by Dr. Juta Hara.

Sapporo, Fishery Institute, Hokkaido Imperial University, some instruction in connection with the courses on fisheries subjects.

Although the foregoing list is almost certainly incomplete, it is nearly enough complete to show that the provisions for instruction in the fundamental principles of oceanography are far from sufficient. One of the desiderata of English speaking students is an adequate text in English on the principles of dynamical oceanography. It has been suggested that either Defant's "Dynamische Ozeanographie" be translated or that McEwen's "A summary of basic principles underlying modern methods of dynamical oceanography" be expanded into a volume. (Both of these publications have already been mentioned.) The adoption of either suggestion would be helpful, but a new text, up to date in all respects with such elaborations as students need, would probably be more satisfactory.



LIST OF INSTITUTIONS ENGAGED IN OCEANOGRAPHIC WORK AND THEIR ACTIVITIES  
—Continued

COUNTRY	INSTITUTION	LOCATION	SEISMOLOGY	HYDROGRAPHIC SURVEYS	TIDES	TEMPERATURE AND SALINITY	PHYSICS	CHEMISTRY	DYNAMICAL OCEANOGRAPHY	SEDIMENTS	METEOROLOGY	GRAVITY	TERRESTRIAL MAGNETISM	FISH	BIOLOGY	INSTRUCTION
Finland	Bureau for Fishery Investigations	Helsinki	..	..	..	..	..	..	..	..	..	..	..	×	..	..
Finland	Laboratory for Hydrobiological Investigations	Helsinki	..	..	..	..	..	..	..	..	..	..	..	..	×	..
Finland	Merenkukuhallitus Merikarttalaitos (Hydrographic Off.)	Helsinki	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Finland	Thalassological Institute	(Helsinki) Helsingfors	..	..	×	×	×	×	×	×	..	..	..	..	..	..
France	Le Laboratoire Arago de Banyuls sur Mer	Arago de Banyuls	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	Station Biologique d'Arcachon	Arcachon	..	..	..	..	..	..	..	..	..	..	..	..	×	..
France	Laboratoire de Luc-Sur-Mer de la Faculté des Sciences de Caen	Calvados (Luc-sur-Mer)	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	Laboratoire de Zoologie et de Physiologie Maritimes du College de France	Concarneau	..	..	..	..	..	×	..	..	..	..	..	×	×	×
France	Laboratoire Maritime du Muséum National d'Histoire Naturelle	Dinard	..	..	..	..	..	×	..	×	..	..	..	×	×	×
France	Laboratoire de Guethary	Guethary	..	..	..	..	..	..	..	..	..	..	..	..	×	..
France	Institut Océanographique du Havre	Havre	..	..	..	..	..	..	..	..	..	..	..	×	×	..
France	Laboratoire de Biologie Marine de "Le Croisic"	Le Croisic	..	..	..	..	..	..	..	..	..	..	..	×	×	..
France	Laboratoire Marion de Marseille	Marseille	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	l'Institut Océanographique	Paris	..	..	..	×	×	×	×	..	..	..	..	..	×	×
France	Office Scientifique et Technique des Pêches Maritimes	Paris	..	..	..	×	..	×	..	..	..	..	..	×	..	..
France	The boat POURQUOI-PAS	Destroyed, Sept., 1936	..	×	..	×	×	×	×	..	..	..	..	..	×	..
France	Service Central Hydrographique	Paris	..	×	×	..	..	..	..	..	×	×	×	..	..	×
France	Station Biologique de Roscoff	Roscoff	..	..	..	..	×	×	..	..	..	..	..	..	×	×
France	Station Biologique de Sète	Sète, Hérault	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	Station Biologique de Tamaris sur Mer	Tamaris sur Mer	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	Station Zoologique de l'Université de Paris à Villefranche sur Mer	Villefranche sur Mer, Alpes Maritimes	..	..	..	..	..	..	..	..	..	..	..	..	×	×
France	Station Zoologique de Wimereux	Wimereux	..	..	..	..	..	..	..	..	..	..	..	..	×	×
Germany	Deutsche wissenschaftliche Kommission für Meeresforschung	Berlin	..	..	..	×	×	×	×	..	..	..	..	×	×	..
Germany	Fischerei-biologische Abtheilung im Deutschen Seefischerei-Verein	Berlin	..	..	..	..	..	..	..	..	..	..	..	×	..	..
Germany	Institut und Museum für Meereskunde	Berlin	..	..	×	×	×	×	×	×	×	..	..	..	×	×
Germany	Nautische Abteilung, Oberbefehlshaber der Kriegsmarine	Berlin	..	×	×	..	..	..	×	..	×	..	×	..	..	×
Germany	Deutsche Seewarte	Hamburg	..	×	×	×	×	×	×	..	×	..	×	..	..	..
Germany	Biologische Anstalt auf Helgoland	Helgoland	×	..	..	×	×	×	×	×	×	..	×	×	×	×
Germany	Meereschemisches Laboratorium der Universität in Kiel	Kiel	..	..	..	..	×	×	..	..	..	..	..	..	..	×
Germany	Meeresgeologische Forschungsstelle der Universität Kiel	Kieler Förde, Ostsee	..	..	..	..	..	..	..	×	..	..	..	..	..	×

[illegible]

LIST OF INSTITUTIONS ENGAGED IN OCEANOGRAPHIC WORK AND THEIR ACTIVITIES  
—Continued

COUNTRY	INSTITUTION	LOCATION	SEISMOLOGY	HYDROGRAPHIC SURVEYS	TIDES	TEMPERATURE AND SALINITY	PHYSICS	CHEMISTRY	DYNAMICAL OCEANOGRAPHY	SEDIMENTS	METEOROLOGY	GRAVITY	TERRESTRIAL MAGNETISM	FISH	BIOLOGY	INSTRUCTION
Netherlands	Department van Defensie, Af-deeling's Hydrografie	Gravenhage	...	×	...	...	...	...	...	...	...	×	...	...	...	...
Norway	Fiskeridirektoratet, Avdeling for Havundersøkelser	Bergen	...	...	...	×	...	...	...	...	...	...	...	×	...	...
Norway	Det Geofysiske Institutt	Bergen	×	...	×	×	×	×	×	...	×	...	×	...	...	×
Norway	Statens Fiskeriforsøksstasjon	Bergen	...	...	...	...	...	...	...	...	...	...	...	×	...	...
Norway	Universitets Biologiske Stasjon	Drøbak	...	...	...	...	...	...	...	...	...	...	...	...	×	×
Norway	Bergens Museums Biologiske Stasjon	Herdla	...	...	...	...	...	...	...	...	...	...	...	...	×	×
Norway	Sjøkartverket (Nautical Charts Office)	Oslo	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Norway	Tromsø Museum	Tromsø	...	...	...	×	...	×	...	...	...	...	...	...	×	...
Norway	Trondheims Biologiske Station	Trondheim	...	...	...	×	...	×	...	...	...	...	...	...	×	...
Poland	Biuro Hydrograficzne Marynarki Wojennej	Warsaw	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Portugal	Aquário Vasco da Gama-Estação de Biologia Marítima	Dãfundo	...	...	...	×	×	×	×	...	...	...	...	×	×	...
Portugal	Direcção de Hidrografia, Navegação e Meteorologia Nautica	Lisbon	...	×	...	...	...	...	...	...	×	...	...	...	...	...
Rumania	Serviciul Hidrografic al Marinei de Razboi	Constantza	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Rumania	State Maritima, Regele Ferdinand I	Agigea, Prov. Constantza	...	...	...	...	...	...	...	...	...	...	...	×	×	...
Scotland	The Torry Research Station	Aberdeen	...	...	...	×	×	×	×	...	...	...	...	×	×	...
Scotland	Marine Laboratory of the Fishery Board for Scotland	Aberdeen	...	...	...	×	×	×	×	...	...	...	...	×	×	...
Scotland	Scottish Marine Biological Association	Millport	...	...	...	×	...	×	...	...	...	...	...	×	×	×
Spain	Laboratorio Oceanografico de Canarias	Las Palmas, Canary Islands	...	...	...	×	...	...	...	...	...	...	...	...	×	...
Spain	Instituto Español de Oceanografía	Madrid	...	...	...	×	×	×	×	×	...	...	...	×	×	...
Spain	Laboratorio de Málaga	Málaga	...	...	...	×	...	×	...	×	...	...	...	×	×	×
Spain	Laboratorio de Palma de Mallorca	Palma de Mallorca	...	...	...	×	...	×	...	×	...	...	...	...	×	×
Spain	Servicio Hidrografico	San Fernando	...	×	×	...	...	...	...	...	×	...	×	...	...	...
Spain	Instituto y Observatorio de Marina de San Fernando	San Fernando	...	×	×	...	...	...	...	...	×	...	×	...	...	...
Spain	Sociedad de Oceanografía de Guipúzcoa	San Sebastian	...	...	...	...	...	...	...	...	...	...	...	...	×	...
Spain	Laboratorio de Santander	Santander	...	...	...	...	...	...	...	...	...	...	...	...	×	×
Spain	Laboratorio de Vigo	Vigo	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sweden	Bornö Research Station	Bornö	...	...	×	×	×	×	×	...	...	...	...	...	...	...
Sweden	Klubbans Biological Station	Fiskebäckskil	...	...	...	...	...	...	...	...	...	...	...	...	×	×
Sweden	Kristinebergs Zoologiska Station	Fiskebäckskil	...	...	...	...	...	...	...	...	...	...	...	...	×	×
Sweden	Oceanografiska Institutionen vid Göteborgs, Högskola	Göteborg	...	...	...	×	×	×	×	...	...	...	...	...	...	×
Sweden	Svenska Hydrografisk-Biologiska Kommissionen	Göteborg	...	...	×	×	×	×	×	...	...	...	...	×	...	...
Sweden	Havsfiskelaboratoriet	Gullmar-fjord	...	...	...	...	...	×	...	...	...	...	...	×	...	...
Sweden	Kungliga Sjökarteverket (Hydrographic Service)	Stockholm	...	×	...	...	...	...	...	...	...	...	×	...	...	...
Tunis	Oceanographic Station of Salambo	Salamambo	...	...	...	...	...	×	...	...	...	...	...	×	...	...

## LIST OF INSTITUTIONS ENGAGED IN OCEANOGRAPHIC WORK AND THEIR ACTIVITIES

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COUNTRY	INSTITUTION	LOCATION	SEISMOLOGY	HYDROGRAPHIC SURVEYS	TIDES	TEMPERATURE AND SALINITY	PHYSICS	CHEMISTRY	DYNAMICAL OCEANOGRAPHY	SEDIMENTS	METEOROLOGY	GRAVITY	TERRESTRIAL MAGNETISM	FISH	BIOLOGY	INSTRUCTION
Turkey	Harta Genel Direktörlüğü Hidrografi Subesi (Hydrographic Sect. Cartograph. Serv. of Army)	Ankara	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Union of South Africa	Fisheries Survey Division	Capetown	..	..	..	×	×	×	..	..	..	..	..	×	..	..
Union of South Africa	Marine Biological Station & Headquarters of Division of Fisheries	Capetown	..	..	..	×	..	..	..	..	..	..	..	×	..	..
Union of South Africa	Marine Biological Station of Div. of Fisheries Survey	St. James Bay	..	..	..	×	..	..	..	..	..	..	..	×	×	..
Union of South Africa	Department van Verdediging, Hydrographic Survey Section	Pretoria	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Yugoslavia	Hidrografski ured Kraljevske Mornarice	Split	..	×	..	..	..	..	..	..	×	..	..	..	..	..
Yugoslavia	Oceanografski Institut Kraljevine Jugoslavije	Split	..	..	..	×	..	..	..	..	..	..	..	×	×	×
U. S. S. R.	The Azerbaidjan Fisheries Station	Baku	..	..	..	..	..	..	..	..	..	..	..	×	..	..
U. S. S. R.	Fisheries Station of Georgia	Batoum	..	..	..	..	..	..	..	..	..	..	..	×	..	..
U. S. S. R.	Manguistau Branch of the Uralo-Caspian Scientific Fisheries Station	Bautino	..	..	..	×	..	..	..	..	..	..	..	×	..	..
U. S. S. R.	The Uralo-Caspian Fisheries Station	Gouriev	..	..	..	..	..	..	..	..	..	..	..	×	..	..
U. S. S. R.	Asov-Black Sea Scientific Research Institute	Kertch	..	..	..	×	..	×	..	..	..	..	..	×	..	..
U. S. S. R.	The Turkmenistan Fisheries Station	Krasnovodsk	..	..	..	..	..	..	..	..	..	..	..	×	..	..
U. S. S. R.	Gidrograficheskij Otdel (Hydrographic Department)	Leningrad	..	×	×	..	..	..	..	..	×	..	..	..	..	..
U. S. S. R.	Daguestan Fisheries Station	Makhach-Kala	..	..	..	..	×	×	..	..	..	..	..	×	..	..
U. S. S. R.	The All-Union Scientific Research Institution of Marine Fisheries & Oceanography	Moscow	..	..	..	×	×	×	×	×	..	..	..	×	..	..
U. S. S. R.	Polar Scientific Research Institute of Marine Fisheries and Oceanography	Murmansk	..	..	..	×	×	×	×	×	..	..	..	×	..	..
U. S. S. R.	Novorossiisk Arnoldi Biological Station	Novorossiisk	..	..	..	..	..	×	..	..	..	..	..	×	..	..
U. S. S. R.	Ukrainian Odessa Fisheries Station	Odessa	..	..	..	×	×	×	..	..	..	..	..	×	..	..
U. S. S. R.	Sevastopol Biological Station	Sevastopol	..	..	..	×	×	×	..	..	..	..	..	..	×	..
Bermuda	Bermuda Biological Station for Research	St. George's West	..	..	×	×	×	×	×	..	..	..	..	..	×	..
Canada	Canadian Hydrographic Service	Ottawa	..	×	×	..	..	..	..	..	..	..	..	..	..	..
Canada	Atlantic Biological Station	St. Andrews	..	..	..	×	×	×	×	..	..	..	..	×	×	..
Canada	Prince Edward Island Marine Station	Ellerslie	..	..	..	×	×	×	..	..	..	..	..	×	..	..
Canada	Meteorological Service of Can.	Toronto	..	..	..	..	..	..	..	..	×	..	..	..	..	..
Canada	Station Biologique du Saint-Laurent	Trois-Pistoles	..	..	..	×	×	×	..	..	..	..	..	..	×	..

LIST OF INSTITUTIONS ENGAGED IN OCEANOGRAPHIC WORK AND THEIR ACTIVITIES  
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COUNTRY	INSTITUTION	LOCATION	SEISMOLOGY	HYDROGRAPHIC SURVEYS	TIDES	TEMPERATURE AND SALINITY	PHYSICS	CHEMISTRY	DYNAMICAL OCEANOGRAPHY	SEDIMENTS	METEOROLOGY	GRAVITY	TERRESTRIAL MAGNETISM	FISH	BIOLOGY	INSTRUCTION
Newfoundland	Fishery Research Lab. of the Newfoundland Fishery Research Commission	Bay Bulls	...	...	...	×	...	×	...	...	...	...	...	×	...	...
United States	Bingham Oceanographic Foundation	New Haven, Conn.	...	...	...	×	×	×	×	...	...	...	...	...	×	...
United States	Dept. of Terrestrial Magnetism, Carnegie Inst. of Washington	Washington, D. C.	...	...	...	×	×	×	×	×	×	×	×	...	×	...
United States	Coast & Geodetic Survey	Washington, D. C.	×	×	×	×	×	...	×	×	...	...	×	...	...	...
United States	U. S. Coast Guard	Washington, D. C.	...	×	...	×	×	×	×	×	...	...	...	...	...	...
United States	Bureau of Fisheries	Washington, D. C.	...	...	...	×	...	×	...	...	...	...	...	×	×	...
United States	Hydrographic Office, U. S. Navy	Washington, D. C.	...	×	×	×	×	...	×	×	×	×	...	...	...	...
United States	U. S. National Museum	Washington, D. C.	...	...	...	...	...	...	...	×	...	...	...	...	×	...
United States	Johnson-Smithsonian Deep-Sea Expedition	Washington, D. C.	...	...	...	...	×	×	...	...	...	...	...	...	×	...
United States	Marine Division, U. S. Weather Bureau	Washington, D. C.	...	...	...	...	...	...	...	...	×	...	...	...	...	...
United States	Tortugas Laboratory	Dry Tortugas	...	...	...	...	...	...	...	...	...	...	...	...	×	...
United States	Univ. of Maine Laboratory	Lamoine, Maine	...	...	...	...	...	...	...	...	...	...	...	...	×	×
United States	Mt. Desert Island Biological Laboratory	Mt. Desert Is., Maine	...	...	...	...	...	...	...	...	...	...	...	...	×	×
United States	Chesapeake Biological Lab.	Solomons Island, Maryland	...	...	...	×	×	×	...	...	×	...	...	×	×	...
United States	Dept. of Oceanography, Museum of Comparative Zoology	Cambridge, Mass	...	...	...	×	×	×	×	×	...	...	...	...	×	×
United States	North Atlantic Fishery Investigations, U. S. Bureau of Fisheries	Cambridge, Mass	...	...	...	×	×	×	×	...	...	...	...	×	×	...
United States	Woods Hole Oceanographic Institution	Woods Hole, Mass.	...	...	×	×	×	×	×	×	×	...	...	...	×	...
United States	Isles of Shoals Marine Zoological Station	Isles of Shoals, New Hampshire	...	...	...	...	...	...	...	...	...	...	...	...	×	×
United States	Dept. of Tropical Research, New York Zoological Society	New York, N. Y.	...	...	...	...	...	...	...	...	...	...	...	...	×	...
United States	U. S. Fisheries Biological Laboratory	Beaufort, N. C.	...	...	...	...	...	...	...	...	...	...	...	×	×	...
United States	Marine Biological Laboratory of R. I. State College	Ft. Kearney, R. I.	...	...	...	×	...	...	...	...	...	...	...	×	×	×
Argentina	Servicio Hidrografico	Buenos Aires	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Argentina	División de Pesca	Buenos Aires	...	...	...	...	...	...	...	...	...	...	...	×	...	...
Brazil	Directoria de Navegação Êtats-Unis du Brésil	Rio de Janeiro	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Brazil	Serviço de Caça e Pesca	Rio de Janeiro	...	...	...	...	...	...	...	...	...	...	...	×	×	×
Uruguay	Instituto de Pesca	Montevideo	...	...	...	...	...	...	...	...	...	...	...	×	...	...
Uruguay	Servicio Hidrografico de la Marina	Montevideo	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Canada	Pacific Biological Station	Nanaimo, B. C.	...	...	...	×	×	×	...	...	...	...	...	×	×	×
Canada	Pacific Fisheries Experimental Station	Prince Rupert, B. C.	...	...	...	...	...	...	...	...	...	...	...	×	...	...

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COUNTRY	INSTITUTION	LOCATION	SEISMOLOGY	HYDROGRAPHIC SURVEYS	TIDES	TEMPERATURE AND SALINITY	PHYSICS	CHEMISTRY	DYNAMICAL OCEANOGRAPHY	SEDIMENTS	METEOROLOGY	GRAVITY	TERRESTRIAL MAGNETISM	FISH	BIOLOGY	INSTRUCTION
United States	Kerckhoff Marine Laboratory	Corona del Mar, Calif.	..	..	..	..	..	..	..	..	..	..	..	..	×	×
United States	Pomona College Marine Laboratory	Laguna Beach, Calif.	..	..	..	..	..	..	..	..	..	..	..	..	×	×
United States	Scripps Institution of Oceanography	La Jolla, Calif.	×	..	×	×	×	×	×	×	×	..	..	..	×	×
United States	Marine Biological Station, Univ. of Southern Calif.	Los Angeles, Calif.	..	..	..	×	..	..	..	..	..	..	..	..	×	×
United States	Hopkins Marine Station of Stanford University	Pacific Grove, Calif.	..	..	..	×	..	×	..	..	..	..	..	×	×	×
United States	California State Fisheries Laboratory	Terminal Island, Calif.	..	..	..	..	..	..	..	..	..	..	..	×	..	..
United States	Coos Bay Marine Station	Coos Bay, Ore.	..	..	..	×	×	×	..	..	..	..	..	..	×	×
United States	U. S. Fisheries Biological Station	Seattle, Wash.	..	..	..	..	..	..	..	..	..	..	..	×	..	..
United States	Washington State Dept. of Fisheries, Div. of Biological Research	Seattle, Wash.	..	..	..	..	..	..	..	..	..	..	..	×	..	..
United States	Biological Dept., Dept. of Game, State of Washington	Seattle, Wash.	..	..	..	..	..	..	..	..	..	..	..	×	..	..
United States	Oceanographic Laboratories, University of Washington	Seattle, Wash.	..	..	..	×	×	×	×	..	×	..	..	..	×	×
United States	Marine Biological Laboratory	Honolulu, Hawaiian Islands	..	..	..	..	..	..	..	..	..	..	..	..	×	×
Chile	Servicio Meteorológico	Santiago	..	..	..	..	..	..	..	..	×	..	..	..	..	..
Chile	Departamento de Navegación	Valparaiso	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Ecuador	Servicio Hidrografico de la Armada	Guayaquil	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Peru	Servicio Hidrografico y Faros	Callao	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Peru	Escuela Naval	La Punta	..	..	..	×	..	..	..	..	×	..	..	..	..	..
Peru	Compañia Administradora del Guano	Lima	..	..	..	×	..	..	..	..	×	..	..	..	×	..
Peru	Servicio Meteorológico	Lima	..	..	..	×	..	..	..	..	×	..	..	..	..	..
Australia	Low Island Queensland	Low Island	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Australia	Australian Hydrographic Service	Melbourne	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Australia	Marine Meteorological Section, Commonwealth Meteorological Bureau	Melbourne	..	..	..	×	..	..	..	..	×	..	..	..	..	..
Australia	Fishery Department	Sydney	..	..	..	×	..	..	..	..	..	..	..	×	..	..
Australia	Marine Laboratory of the University of Sydney	Sydney	..	..	..	×	×	×	..	..	..	..	..	..	×	×
China	Summer Survey of the Marine Biological Association of China	Amoy	..	..	..	..	..	..	..	..	..	..	..	..	×	×
China	Hydrographic Department of the Chinese Navy	Shanghai	..	×	×	..	..	..	..	..	..	..	..	..	..	..
China	Tinghai Marine Station	Tinghai	..	..	..	×	..	×	..	..	..	..	..	..	×	..
China	Tsingtao Aquarium	Beach Park, Tsingtao	..	..	..	..	..	..	..	..	..	..	..	..	×	×
China	Dept. of Oceanography Tsingtao Observatory	Observatory Hill, Tsingtao	..	..	×	×	..	×	×	×	×	..	..	..	×	..
French Indo-China	Institut Océanographique de l'Indochine	Nhatrang, Annam	×	..	×	×	..	×	×	×	..	..	..	×	×	..
Hong Kong	Royal Observatory	Kowloon	×	..	..	..	..	..	..	..	×	..	×	..	..	..

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Japan	Akkeshi Marine Biological Station	Akkeshi Gulf	..	..	..	..	..	..	..	..	..	..	..	..	×	×
Japan	Amakusa Marine Biological Laboratory	Tomioaka, Amakusa	..	..	..	..	..	..	×	×	..	..	..	..	×	×
Japan	Marine Biological Station of Asamushi	Asamushi	..	..	..	×	..	..	..	..	..	..	..	..	×	×
Japan	Imperial Marine Observatory	Kobe	..	..	×	×	×	×	×	..	×	..	..	..	×	..
Japan	Kominato Marine Biological Laboratory	Kominato	..	..	..	×	×	×	×	..	..	..	×	×	×	..
Japan	Institute of Physical Oceanography	Kyoto	..	..	×	×	×	..	×	..	..	..	..	..	..	×
Japan	Misaki Marine Biological Station	Misaki	×	..	..	×	..	..	..	..	..	..	..	..	×	×
Japan	Miyako Meteorological Observatory	Miyako	..	..	..	×	..	×	..	×	..	..	..	..	..	..
Japan	Inst. Algological Research	Muroran, Hokkaido	..	..	..	..	..	..	..	..	..	..	..	..	×	..
Japan	Palao Tropical Biol. Station	Korror Id., Palao Group	..	..	..	×	×	×	..	×	..	..	..	..	×	..
Japan	Seto Marine Biological Laboratory	Seto-Kanayama	..	..	..	..	..	..	..	..	..	..	..	..	×	×
Japan	Shimoda Marine Biological Station	Shimoda, Kanazawa Prefecture	..	..	..	×	×	×	..	×	×	..	×	..	×	×
Japan	Mitsui Marine Biological Station	Susaki, near Shimoda	×	..	..	..	..	..	..	..	..	..	..	..	×	..
Japan	Imperial Fisheries Experimental Station	Tokyo	..	..	..	×	×	×	×	..	..	..	..	×	..	..
Japan	Imperial Fisheries Institute	Tokyo	..	..	..	×	×	×	..	..	..	..	×	×	×	×
Japan	Hydrographic Department of the Imperial Japanese Navy	Tokyo	..	×	×	×	×	×	×	×	×	×	×	..	..	×
Japan	Central Meteorological Observatory of Japan	Tokyo	×	..	×	×	×	×	..	..	×	..	×	..	×	..
Japan	Government Fishery Experimental Station of Chosen	Fusan, Korea	..	..	..	..	..	..	..	..	..	..	..	×	..	..
Netherlands East Indies	Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia	Batavia	×	..	..	×	..	..	..	×	..	..	..	..	..	..
Netherlands East Indies	Laboratorium voor het Onderzoek der Zee	Batavia	..	..	..	..	..	..	..	..	..	..	..	×	×	..
New Zealand	Porto Bello Marine Fisheries Investigation Station	Dunedin	..	..	..	×	..	..	..	..	..	..	..	×	×	..
Philippine Is.	Bureau of Science, P. I.	Manila	..	..	..	..	..	..	..	..	..	..	..	×	..	..
Philippine Is.	Coast and Geodetic Survey	Manila	..	×	×	..	..	..	..	..	..	..	..	..	..	..
Philippine Is.	Fish & Game Administration	Manila	..	..	..	..	..	..	..	..	..	..	..	×	..	..
Philippine Is.	Manila Observatory	Manila	×	..	..	..	..	..	..	..	×	..	×	..	..	..
Philippine Is.	Puerto Galera Marine Biological Lab., Univ. of Philippines	Puerto Galera	..	..	..	..	..	..	..	..	..	..	..	..	×	×
Siam	Krom Uthoksat (Hydrographic Serv., Royal Siamese Navy)	Bangkok	..	×	×	..	..	..	..	..	×	..	..	..	..	..
Siberia	Kamchatka Fisheries Station	Petropavlovsk	..	..	..	×	..	×	..	..	..	..	..	×	×	..
Siberia	Pacific Institute of Fisheries and Oceanography	Vladivostok	..	..	..	×	..	×	..	..	..	..	..	×	×	..

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Strts. Settlmts. & Fed. Malay States	Department of Fisheries	Singapore	...	...	...	...	...	...	...	...	...	...	...	×	...	...
Egypt	Marine Biological Station of the University of Egypt	Ghardaqa	...	...	...	×	...	×	...	...	...	...	...	...	×	×
India	Marine Survey Office, British India	Bombay	...	×	...	...	...	...	...	...	...	...	...	...	...	...
India	Zoological Survey of India	Calcutta	...	...	...	...	...	...	...	...	...	...	...	...	×	...
India	Ennur Biological Station	Ennur	...	...	...	...	...	...	...	...	...	...	...	×	×	×
India	Krusadai Biological Station	Krusadai Island	...	...	...	×	...	...	...	...	...	...	...	×	...	...
India	Madras Aquarium	Madras	...	...	...	...	...	×	...	...	...	...	...	...	×	...
India	Madras Fisheries Department	Madras	...	...	...	×	...	...	...	...	...	...	...	×	...	...
India	Meteorological Department Government of India	Poona	...	...	...	...	...	...	...	...	×	...	...	...	...	...
India	West Hill Biological Station	West Hill, Calicut, Malabar Coast	...	...	...	×	...	...	...	...	...	...	...	×	...	...

# INTERNATIONAL INSTITUTIONS

## Association Internationale d'Océanographie Physique ('37)

*History or origin:* Successor to the Section d'Océanographie of the International Union of Geodesy and Geophysics. This Union was founded in 1919 and had for one of its original constituents the "Section d'Océanographie Physique." The first General Assembly of the Section was held at Paris in 1921 and its scientific scope was summarized as follows:

"Morphology of the sea bottom,  
Morphology of the surface of the oceans and seas,  
Movements of water masses, and  
Physical and chemical studies of sea water."

A General Assembly of the Section was held at Rome in 1922 on the occasion of the first General Assembly of the Union. At this Assembly it was decided to invite the coöperation of biologists and the Section was subsequently styled "Section d'Océanographie."

A General Assembly of the Union was held at Stockholm in 1930, the last under the original Statutes. New statutes of the Union were drawn up and the Sections were replaced by Associations. It was decided that the "Section d'Océanographie Physique," and at the General Assembly at Lisbon in 1933, statutes of the Association were drawn up.

*Location:* No permanent headquarters.

*Organization to which attached:* Union Géodésique et Géophysique Internationale.

*Purposes:* (1) To promote the study of problems which concern physical oceanography.

(2) To stimulate and coördinate those researches that need the coöperation of several countries and to assure their scientific discussion as well as their publication.

(3) To assist special researches, such as a comparison of instruments used in different countries.

*Scope of activities:* The section of oceanography in which mathematics, physics, and chemistry are utilized for the scientific study of the sea.

*Equipment:* None.

*Staff:* Officers and Executive Committee for the period commencing December 24, 1936.

President, Professor B. Helland-Hansen, Det Geofysiske Institutt, Bergen, Norway.

Vice President, Monsieur E. Fichot, 47 Avenue de Neuilly, Neuilly sur Seine.

General Secretary, Professor J. Proudman, The University, Liverpool, 3.

Members of the Executive Committee, to retire in 1939: Mr. D. J. Matthews, Professor T. G. Thompson, Professor R. Witting.

Members of the Executive Committee, to retire in 1942: Professor M. Knudsen, Dr. T. Okada, Dr. A. Ramalho, Dr. P. M. van Riel.

*Provisions for visiting investigators:* None.

*Income:* Sources: Subscriptions from adhering countries received through the Union Géodésique et Géophysique Internationale.

Amount: Variable.

*Provision for publication of results:* Two series of special publications: "Publications Scientifiques," and "Procès-Verbaux."

## Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée (37)

*History or origin:* The organization<sup>1</sup> meeting of this Commission was held in Madrid on November 17 to 20, 1919, at the invitation of the Spanish Government. The King of Spain presided at the first meeting of the conference. The subsequent meetings were presided over by His Serene Highness, the Prince of Monaco. The following governments were represented by delegates: Egypt, Spain, France, Greece, Italy, Monaco, Tunis, and Turkey.

*Location:* The Commission meets at different places as determined by the Central Bureau.

*Independent organization* composed of delegates of

<sup>1</sup> Commission internationale pour l'Exploration scientifique de la Mer Méditerranée Conférence de Madrid, Bull. Comm. internat. l'Explor. sci. Mer Méditerranée, no. 1, pp. 1-24, January 15, 1920.

Commission internationale pour l'Exploration scientifique de la Mer Méditerranée, Bull. Comm. internat. l'Explor. sci. Mer Méditerranée, no. 2, pp. 1-23, February 29, 1920.

the different contracting states and administered by a Central Bureau appointed for a period of five years. The Commission meets every two years and fixes the place and date of the following meeting. The Central Bureau is composed of a president, a secretary-general, one member representing each adhering state, and associate secretaries, who are the secretaries of the different national commissions of the adhering states.

*Purpose:* The purpose is to afford means for achieving coördinated investigations of the oceanography and the fisheries of those countries whose shores border the Mediterranean Sea.

*Scope of activities:* Each country that adheres to the Commission has its own national commission, the secretary of which must keep the Secretary-General, and through him the Central Bureau, informed of the activities of the country of whose national commission he is a member.

Besides the national commissions, there are special committees on hydrologic and biologic subjects.

Under hydrology, five sub-committees were originally designated: (1) tides, (2) currents, (3) chemistry of sea water and the properties of normal water, (4) marine meteorology, (5) methods and instruments to be used in the collection of marine organisms. There are also instructions for the operations to be conducted at different oceanographic stations and the instruments to be used.

The biological work is divided into general biology and applied biology. Special instructions are given for cruises, the making of biological observations, particularly with reference to fishes of economic value, and for the distribution of material to specialists on different biological groups.

Under work at the different laboratories, each laboratory is instructed to prepare a bathymetric chart, on a scale of  $\frac{1}{50,000}$ , and a lithologic chart of the sea bottom of the region in which it is situated. Each laboratory will also make hydrologic studies and biologic studies, especially of the useful animals and plants. The operations on cruises for biologic purposes are to be made according to a program decided upon by the Commission.

At the meeting of the Commission in Bucarest (Roumania), in September, 1935, the reporters appointed for different subjects were as follows:

Océanographie physique et hydrologie marine, M. G. Belloc and R. de Buen.

Chimie générale, M. Picotti.

Méthodes acoustiques, P. Marti.

Chimie marine et industrielle, M. Boury.

Géophysique, G. Galbis.

Marées et niveau moyen, F. Vercelli.

Biologie générale, U. d'Ancona.

Plancton, R. Issel.

Biologie industrielle des delphinidés, G. Brunelli.

Thon rouge et sa pêche, H. Heldt.

Clupéidés et leur pêche, F. de Buen.

Crustacés (Biologie), Mme. H. Heldt.

Éponges et coraux, MM. M. Sella.

Botaniques (plantes marines), J. Politis.

Protistologie, J. Georgevitch.

Statistique des pêches, D. Rémy.

Faunistique des îles de la Méditerranée occidentale, L. Germain.

Études générales sur la Méditerranée orientale, G. Antipa.

Relations entre la Méditerranée et la mer Rouge, H. Faouzi.

Géologie sous-marine, G. Georgalas.

Hygiène et salubrité des coquillages, M. Teissonnière.

*Equipment:* The equipment, shore laboratories and vessels, belongs to the different adhering countries.

*Officers of the Central Bureau:*

President, Admiral Thaon di Revel.

Vice-Presidents, Professor Odon de Buen, Professor G. Antipa.

Secretary-General, Dr. Edouard le Danois.

Honorary President, Professor Vito Volterra.

Honorary Secretary-General, Dr. J. Richard.

One member representing each adhering state, Cyprus, Egypt, Spain, France, Greece, Monaco, Zone espagnole du Protectorat du Maroc, Palestine, Roumanie, Tunisie, Turkey, and Yugoslavia.

Associate secretaries, one from each country.

*Provisions for visiting investigators:* Visitors can be accommodated at the shore laboratories, and they may at times participate in cruises.

*Income:* Each adhering state pays annually a sum of at least 5,000 francs.

*Provision for the publication of results:* Ten numbers of the Bulletin of the Commission were published in Monaco between January 15, 1920, and December, 1924. The format of the regular publication of the Commission was changed beginning with the meeting of the Central Bureau, in Paris

in February, 1925. In addition to the Bulletins the results of the different national commissions are to be published, according to rules established by the Central Bureau, by the countries adhering to the Commission. The publications may be in English, Spanish, French, Greek, or Italian.

The preparation and publication of bathymetric charts and of the lithologic charts of the sea bottom have already been mentioned. The combination of the different partial charts into a complete chart for the Mediterranean has been considered. It was also proposed to undertake the publication of separate photographs of an atlas to illustrate the fauna and flora of the Mediterranean, of which twenty parts had been issued prior to December, 1934, and to publish a manual of oceanography and an encyclopedia of physical oceanography.

The Italian Delegation of the International Commission for the Scientific Exploration of the Mediterranean Sea has published since 1908 *Bibliographia Oceanographica*, and it also published *Monografia della Laguna Venezia* and *Manuale di Oceanografia*.

#### Consejo Oceanográfico Ibero-Americano ('34)

*History or origin:* The Consejo Oceanográfico Ibero-Americano was organized in Madrid on March 1, 1929, by diplomatic agreement signed by representatives of the Argentine, Costa Rican, Ecuadorian, Salvadorian, Spanish, Guatemalan, Mexican, Panamanian, Peruvian, Dominican, and Uruguayan republics. The member countries, in September, 1932, were Argentina, Costa Rica, Ecuador, Salvador, Spain, Guatemala, Mexico, Panama, Peru, Republica Dominicana, and Uruguay. The organization was originally intended to be composed of those countries in the Iberian Peninsula and America in which the language was either Spanish or Portuguese. The duration of the Council was to be for a term of eight years, which could be automatically renewed. The Council is expected to meet every three years. Subsequent to the organization meeting it has been proposed to admit to membership in the Council other American and European countries that have possessions in America. The extended membership would include the United States of America, Canada, Newfoundland, France, England, Holland, and Denmark. These countries have accordingly been invited to send delegates to the next meeting of the Council which was to

have taken place in Madrid in June, 1933, but because of adverse circumstances, the meeting was postponed until April, 1935.

*Location:* Madrid.

*Organization to which attached:* Independent organization supported by the participating governments.

*Purposes and scope of activities:* To promote, coordinate, and standardize oceanographic, fisheries, hydrographic, and limnologic investigations within those countries that belong to the Council. In order to accomplish this purpose, each member state will form a national committee. The different national committees may act either alone or in connection with other national committees. They may submit to the Council for consideration and discussion any pertinent question. The Council will also publish the results of scientific works which are of interest to the member states and it will accumulate a library, including charts, on various oceanographic, fisheries, hydrographic, and limnologic subjects. The Council will also serve as a medium for exchanging information between the different member countries and between the institutions in countries that do not adhere to it.

*Equipment:* Administrative offices and a library.

*Staff:* Executive Committee, Prof. Odón de Buen, President; Admiral Ernesto Caballero y Lastres, Vice-President; Prof. Rafael de Buen, Secretary-General.

*Provisions for visiting investigators.*

*Income:* Source: Contributions from the different adhering countries.

Amount: There is an assessment unit of 300 pesos gold, which can be changed by the Finance Committee of the Conference according to circumstances.

The annual contribution of each country and the number of votes is as follows:

POPULATION OF THE COUNTRY	NUMBER OF VOTES	NUMBER OF ASSESSMENT UNITS TO BE CONTRIBUTED
Less than one million inhabitants.....	1	2
Between one million and three million...	2	2
Between three and five million.....	3	3
Between five and ten million.....	4	5
Between ten and fifteen million.....	5	7
Between fifteen and twenty million.....	6	10
More than twenty million.....	7	13

*Provisions for the publication of results:* "Memorias," of which Nos. 1-16, 1930-1934 have been issued.

"Revista," of which vols. 1-6, 1930-May, 1935 have been published.

### Conseil Permanent International pour l'Exploration de la Mer ('37)

*History or origin:*<sup>2</sup> The first International Conference on the exploration of the sea took place in Stockholm on the 15th of June, 1899, in response to an invitation from His Majesty, King Oscar II of Sweden. This invitation was extended by the Swedish Ministry of Foreign Affairs to the governments of Germany, Denmark, Great Britain, and Ireland, as well as to the Norwegian, Netherlands, and Russian governments, and transmitted a program indicating the purpose of the Conference, which was to undertake in the interests of fisheries, the exploration of the Arctic Ocean, the North Sea, and the Baltic by means of international endeavor. Translations of extracts from the program proposed by His Majesty, King Oscar, to the Conference are as follows:

#### I

"Periodic and simultaneous scientific observations, four times a year, on the salinity of sea water, its temperature, its content of different gases, the quality and quantity of the plankton at places indicated by previous researches as being the most important.

"1. The system of currents of the North Atlantic and the changes which take place there during the different seasons, for upon them depends the variation in the plankton, or the food of fishes which is suspended in the water, as well as the appearance and disappearance of migrant fishes, in the above mentioned marine areas;

"2. The temperature of, and the quantity of heat which is found in the water layers at different seasons and on which depend the climate and the weather in the countries bordering the North Sea as well as in all of northern Europe, especially in the winter and in the spring.

In order to answer these questions the Conference should be charged:

a. To organize a complete network of observations and to divide them according to territory to be studied between the contracting parties according to the principle that each country should make scientific researches in that part of the sea which is nearest its own coast;

b. To fix the periods of the simultaneous observations that are to be made;

c. To determine the methods to be used in making soundings on board ships and in the analytical work in laboratories. It will be necessary, for example, to take measures to ascertain the exact relations between the salinity of the waters of the sea, its specific gravity, and its temperature, and to ascertain the best methods for determining these constants, as well as to test methods for the qualitative and quantitative estimation of plankton (under which is included the floating eggs and the larvae of fishes);

d. To indicate the general bases for the coordination of the results obtained and their publication.

#### II

"1. By means of fishery experiments, undertaken at the same time as the scientific investigations on the hydrographic and biological features, under the direction of qualified scientific specialists on board ships equipped for this purpose. As examples of this kind, there may be cited the investigations of Hensen and of Apstein in the North Sea in 1895 and those of the Fishery Board along the coast of Scotland during several summers, and of the Danish Biological Station in the Cattegat.

"2. By sending aboard ordinary fishing vessels (trawlers, drifters, and vessels engaged in the capture of whales and seals) assistants, who simultaneously with fishing, would make hydrographic and biological observations on the food content for fishes of the water and of the sea bottom, as well as on the eggs and larvae, and they would observe the quantity, the size and the stage of development of the fish taken on the fishing grounds with different gear.

#### III

"1. An agreement between different maritime stations of the North Sea for the division of work and the study of certain questions important for the fisheries. For example,

- a. The conditions of existence of oysters and lobsters, their propagation and growth;
- b. The racial characters, morphologic and physiologic of the edible fishes, such as the herring, plaice, cod, mackerel, et cetera.

The Conference should endeavor to organize the scientific work in common and to make a division of the work between all those stations, which today work in isolation, and to give them every possible support by international coöperation."

At the first Conference, which was opened on the 15th of June, 1899, the following countries were represented: Germany, Denmark, Great Britain and Ireland, Norway, the Netherlands, Russia, and Sweden. The following is a translation of the resolutions which were unanimously adopted:

"Considering that a rational exploitation of the sea should be based in so far as possible on scientific research,

<sup>2</sup> The account here given of the establishment of the International Council for the Exploration of the Sea is based upon an article entitled "La fondation du Conseil International pour l'Exploration de la Mer par les Conférences de Stockholm (1899), de Christiana (1901), et de Copenhague (1902)," in *Rapport Jubilaire (1902-1927): Cons. Perm. internat. pour l'Explor. de la Mer, Rap. et Proc.-Verb. des Réun.*, vol. 47, pt. I, pp. 3-29, 1928. A number of the passages in this article have been translated into English, other parts are briefly summarized or merely mentioned.

and considering that international coöperation is the best means for obtaining satisfactory results in this direction, especially if during the investigations it is kept in view that their principal end is the promotion and improvement of fisheries by the aid of international agreement, this international assembly has resolved to recommend to the states in question the following plan of research which should be put into execution for a period of at least five years.

"After each delegate had communicated the instructions received from his government the work was divided into sections of which the first (A) should elaborate the program of hydrographic work and the second (B) that of the biological work. At last a common program was prepared for the organization and the administration of the international coöperation."

*Program for the hydrographic and biological work on the northern areas of the Atlantic Ocean, in the North Sea, the Baltic, and adjacent seas:*

The principal lines of this program included:

The establishment of an International Council for the Exploration of the Sea, composed of two delegates from each country who were to elect a president, vice-president, a secretary-general, and substitutes, and establish the statutes and the order of work of the institution;

Statistics on fisheries which would be prepared for the participating countries according to principles adopted in common;

The establishment of a central laboratory for physical and chemical researches which are related to the exploration of the sea;

The synoptic study of the sea during all seasons by means of periodic voyages within the areas to be investigated.

These general resolutions are followed by three sections, (A) Hydrographic work, (B) Biological work, (C) Organization of the central bureau.

*A. Hydrographic work*

I

"The hydrographic researches should have for their object: The distinction between the different layers of water according to their geographical distribution, their depth, their temperature, their salinity, their content of gas, plankton, currents, in order to ascertain the fundamental principles not only for the determination of the external environment of the useful marine animals, but also for meteorological predictions for extended periods in the interest of agriculture.

II

"As the hydrographic conditions are subject to seasonal changes and as these influence seriously the distribution and the condition of life of useful marine animals and the condition of the weather and other

meteorological conditions in general, it is desirable that the observations be made in so far as possible simultaneously during the four typical months, February, May, August, and November, at certain definite points along the same determined lines."

Following the two foregoing paragraphs there are eight other paragraphs giving instructions regarding the hydrographic work. These are on pages 12 to 15 of the article here cited. They give an interesting account of the details of the plan for the hydrographic work but it is scarcely necessary to translate them for this statement.

*B. Biological work*

I

"(a) Determination of the geographic and bathymetric distribution of the eggs and larvae of commercially valuable marine fishes, for example, according to such quantitative methods as those of Hensen, and with special references to the most important fishes, as plaice, cod and haddock, herring, etc.

"(b) Continuous investigation of the life history and the conditions of life of young fishes of economic species in the post larval stages and up to maturity, paying particular attention to their local distribution.

"(c) Systematic observations of marketable fishes in the mature state with reference to local varieties and migrations, their conditions of life, food (for example by examining stomach contents), and their natural enemies, that is to say observations on the presence and nature of the food of fishes on the bottom of the sea, on the surface, and in the intermediate waters to a depth of at least 600 meters.

"(d) Determination of the periodic variations in the presence, abundance, and mean size of useful fishes, and their causes.

II

"(a) Experimental fishing on known fishing grounds during the time of fishing as well as outside those areas and at other times.

"(b) Preparation of uniform statistics of the result of these catches, indicating in detail the number of species, the size and weight, and the condition of the fish: for example, as the 'Scottish Fishery Board' has done on board the GARLAND.

"(c) The uniform use of gear appropriate to the experimental capture of fishes of different species and different sizes.

"(d) The experimental marking and liberation of fish, for example, of the plaice in as large quantities as possible and in extensive areas, as has been done, for example, by Dr. C. G. Joh. Petersen and Dr. T. W. Fulton (Reports of the biological station of Denmark and the 'Scottish Fishery Board'), and others.

III

"(a) It is desirable to collect uniform statistics on the number, the weight, and the value of the fish caught, on

the means employed for the fishery, and on the people engaged in it, as for example, in the General reports of the 'Scottish Fishery Board.'

"(b) It is necessary to collect material for the preparation of charts indicating the fishing grounds and the kind of fishery which is prosecuted there."

From the account which has been given of the establishment of the International Council for the Exploration of the Sea, it is obvious that the Council was founded to aid the fishery industry in the northeast Atlantic and its connecting waters.

*Location:* Copenhagen was selected as the seat of the Central Office of the Council, which in 1936 was transferred to Charlottenlund Slot, eight kilometers north of the center of Copenhagen.

*Organization and scope of activities:* The present organization of the International Council may be taken from the account of the recent reunion in Copenhagen in June, 1936. There is at the top the Bureau of the Council, which at present is composed of five members and of which Mr. H. G. Maurice is the president. Besides the Bureau there are members of the Council and experts. Each of the following countries has two members of the Council and as many experts as it may desire: Germany, Belgium, Denmark, Spain, Finland, France, Great Britain, Irish Free State, Latvia, Norway, the Netherlands, Poland, Portugal, and Sweden. Under the Council there are seventeen committees as follows:

Consultative Committee, composed of sixteen members, of which Professor J. Hjort is chairman.

North Western Area Committee, composed of six members, of which Dr. Å. Vedel Tåning is chairman.

North Eastern Area Committee, composed of nine members, of which Professor J. Hjort is chairman.

Atlantic Slope Committee, composed of ten members, of which Dr. Edouard le Danois is the chairman.

Atlantic Committee, composed of members of the Atlantic Slope Committee and of the North Western Area Committee, of which Dr. Edouard le Danois is chairman.

Combined North Sea and Eastern Channel Committee, of which Professor G. Gilson is the chairman.

Northern North Sea Committee, composed of eight members, of which Dr. R. S. Clark is the chairman.

Southern North Sea Committee, composed of nine members, of which Dr. A. Bückmann is chairman.

Transition Area Committee, composed of five members, of which Dr. H. Blegvad is chairman.

Baltic Area Committee, composed of seven members, of which Dr. K. A. Andersson is chairman.

Hydrographic Committee, composed of twenty-five members, of which Professor Martin Knudsen is chairman.

Plankton Committee, composed of twenty members, of which Professor H. H. Gran is chairman.

Statistical Committee, composed of fifteen members, of which Sir D'Arcy W. Thompson is chairman.

Salmon and Trout Committee, composed of thirteen members, of which Professor M. Siedlecki is chairman.

Whaling Committee, composed of eight members, of which Professor J. Hjort is chairman.

Editorial Committee, composed of ten members of which Professor O. Pettersson is chairman.

Finance Committee, composed of six members, of which the President of the Bureau of the Council is chairman.

The various committees consider investigations which logically fall within the scope of their activities and make recommendations to the Council. As a result of the consideration given various problems, it is possible to decide upon specific programs which may be carried out by those especially concerned. As the members of the Council have official connections, they are able to direct the efforts of the organization with which they are connected to the end that the decisions of the officials of the Council may be made effective. The reports of the committees are published in the series "Rapports et Procès Verbaux des Réunions."

The headquarters of the Council are situated in the Charlottenlund Castle, Denmark where the International Council's office work is managed by an Administrative Secretary, Captain W. Nellemose, who is assisted by a Hydrographer, Dr. J. P. Jacobsen, and a permanent staff of 8 assistants.

*Income:* The funds for the operation of the Council are derived from contributions from the governments that adhere to it. The estimate of these contributions for the year 1936-1937 is 155,000 Danish Kroner.

*Provisions for publication:* The International Council issues several series of reports, as follows:

Les Rapports et Procès Verbaux, of which one hundred and one volume have been issued, to date,

Les Bulletins hydrographiques, of which volumes have been issued yearly from 1908 to 1936 inclusive,

Les Bulletins Statistiques, of which twenty-four volumes have been issued to date,

Le Journal du Conseil, of which eleven volumes have been issued to date, and

Les Publications de Circonstance which have been discontinued.

La Faune Ichthyologique, of which sixteen covers with 24 sheets each have been issued (two or three further covers to finish this publication).

*Concluding remarks:* Although the International Council was established primarily for the purpose of aiding the fisheries industry, many researches of significance to general oceanography have been prosecuted under its auspices. The Jubilee report for the meeting in 1927, twenty-five years after the establishment of the Council, contains a number of articles on what had been accomplished in the different countries. Besides the work on fishes, this report contains accounts of investigations in dynamical and chemical oceanography and a variety of biological investigations such as a paper on micro-biology by F. Liebert of the Netherlands, plankton investigations by C. H. Ostenfeld, and the conditions of life for plankton in the coastal waters of northern Europe by H. H. Gran.

As a further indication of the kind of investigations cultivated under the auspices of the International Council, the report of the proceedings of a special meeting on "General marine physiology, conditions of growth of phytoplankton," held on March 27, 1931, at Copenhagen, may be cited. Besides the preface by Dr. John Hjort, this number of the *Rapports et Procès Verbaux des Réunions*, volume 75, contains the following articles:

- "Dissolved substances as food of aquatic organisms," by August Krogh,
- "On the conditions for the production of plankton in the sea," by H. H. Gran,
- "Biochemical and biological investigations of the variations in the productivity of the west Norwegian oyster pools," by T. Gaarder and R. Späreck,
- "Eine biologisch chemische Studie in Hafenwasser von Helsingfors," by Kurt Buch,
- "Beziehungen zwischen Kalkgehalt des Meerwassers und Plankton," by H. Wattenberg, and
- "On the rate of photosynthesis by diatoms," by H. W. Harvey.

Two of the more recent volumes of the *Rapports et Procès-Verbaux des Réunions* will be mentioned. One is Volume 95, March 1936, the contents of which are as follows:

A review of some aspects of Zooplankton research, by F. S. Russell, Plymouth.

Further investigations upon the photosynthesis of phytoplankton by constant illumination, by H. Höglund and S. Landberg, Bornø.

The continuous plankton recorder: a new method of survey, by A. C. Hardy, Hull.

Die Ergebnisse der internationalen hydrographischen Beobachtungen im Kattegat im August 1931, by B. Schulz, Hamburg.

The second part of volume 101, July 1936, is devoted to a series of papers entitled "The measurement of submarine light and its relation to biological phenomena." This number contains six articles, two by biologists and four by physicists.

#### International Committee on the Oceanography of the Pacific ('37)

*History or origin:*<sup>3</sup> At the final general meeting of the Second Pan-Pacific Science Congress held in Sydney, Australia, in September, 1923, an International Committee was established to collect data on the temperatures, chemical features, and currents of the Pacific Ocean, the committee to be composed of at least one representative of each country represented at the Third Pan-Pacific Congress and in which investigations of the kind indicated were being actively prosecuted.

At the Third Pan-Pacific Science Congress, it was decided to discharge the Committee on the Physical and Chemical Oceanography of the Pacific and to replace it by a Committee on the Oceanography of the Pacific which would be more broadly representative of the science. Accordingly the following four resolutions were adopted:

#### RESOLVED:

I. That the President or Administrative Council of the Pacific Science Association appoint the Chairman of the Committee on Oceanography of the Pacific and that the appropriate scientific body in each country represented in the Association appoint for the International Committee a member who shall be the Chairman of a National Committee for his country.

II. That at least three subcommittees be formed on (a) Physical and Chemical Oceanography; (b) Fundamental Marine Biology; (c) Fisheries Technology.

III. That the closest possible relations be cultivated between the different National Committees and between the members of the special Subcommittees for the different countries; that they submit their respective programs one to another, seek suggestions and advice regarding the different features of their work, and

<sup>3</sup> Committee on the Chemical and Physical Oceanography of the Pacific, report of the Chairman, T. Wayland Vaughan. Third Pan.-Pac. Sci. Cong., Tokyo, 1926, Proc., vol. 1, pp. 141-167, 1929. (Preprint, 1927.)

Reports of the International Committee on the Oceanography and the Coral Reefs of the Pacific, T. Wayland Vaughan, Chairman. Fourth Pac. Sci. Cong., Java, 1929, Proc., vol. 1, pt. 2, pp. 1-136, 1930.

International Committee on the Oceanography of the Pacific, Report of the Chairman, T. Wayland Vaughan. Fifth Pac. Sci. Cong., Canada, 1933, Prof., App. 1, pp. 245-384, 1934.

endeavor to bring about the greatest degree of standardization and coördination; and that the proceedings of the different National Committees and Subcommittees be reported to the International Chairman, who shall submit a general report to the Pacific Science Association.

IV. That the work of the Committee be conducted with the intent of establishing for the Pacific an institution similar to the North Atlantic International Council for the Exploration of the Sea.

*Location:* The Committee has no permanent central office. The chairman is appointed at the end of each Pacific Science Congress and serves until his successor is designated. The Committee meets in connection with the Pacific Science Congresses.

*Organization to which attached:* Pacific Science Association, of which it is a standing Committee.

*Purposes:* To stimulate oceanographic research in the Pacific, to enable the different countries whose shores border the Pacific or which have possessions in the Pacific to coördinate their researches, and to standardize the methods and appliances used in oceanographic research.

*Scope of activities:* Each national committee was empowered by the Fifth Pacific Science Congress to establish five subcommittees as follows: physical and chemical oceanography, marine biology, corals and coral reefs, fisheries, and fishery technology.

*Equipment:* None.

*Staff:* The composition of the International Committee on the Oceanography of the Pacific in February, 1936, was as follows:

Australia, Mr. E. C. Andrews, formerly Government Geologist, New South Wales, Sydney, Australia.

Canada, Prof. C. McLean Fraser, University of British Columbia, Vancouver, B. C.

China, Mr. P. Z. Tsiang, Tsingtao Observatory, Tsingtao.

France.

French Indo-China, Dr. P. Chevey, active director, Institut Océanographique de l'Indochine.

Great Britain, Sir Gerald Lennox-Conyngham, Cambridge University.

Japan, Prof. H. Yabe, Tohoku Imperial University, Sendai.

Netherlands, Prof. Dr. E. van Everdingen, Jr., Director, Netherlands Meteorological Institute, De Bilt, Netherlands.

Netherlands East Indies, Prof. Dr. J. Boerema, Director, Royal Magnetic and Meteorological Observatory, Batavia.

New Zealand, Dr. Patrick Marshall, New Zealand Institute, Wellington.

Philippine Islands, Dr. Manuel L. Roxas, Chairman, Committee Physical-chemical Oceanography, National Research Council, University of the Philippines, Manila.

Union of the Soviet Socialist Republics, Prof. J. M. Schokalsky, Academy of Science, Leningrad.

United States of America, Prof. T. G. Thompson, Director, Oceanographic Laboratories, University of Washington, Seattle, Washington, Chairman.

*Provisions for visiting investigators:* None.

*Income:* No special funds are allotted.

*Provisions for publication:* The reports on the work of the Committee are published in the Proceedings of the different Pacific Science Congresses.

#### International Fisheries Commission ('37)

*History or origin:* Established by a treaty ratified on October 21, 1924, between Canada and the United States for preservation of the halibut fishery of the northern Pacific Ocean including the Bering Sea.

The treaty provided for an entire cessation of halibut fishing for three months of each year and for the appointment of an International Fisheries Commission, to consist of two commissioners from each country. The duties of the Commission were to make a thorough investigation into the life history of the halibut, to report the results of the same to the two governments, and to make recommendations regarding any desirable changes in the closed season and as to other regulation of the fishery for its preservation and development.

As a result of its biological and statistical studies of the species and its fishery, the Commission became convinced that the stocks of halibut could not stand the intensity of fishing to which they were being subjected, and that additional regulation was necessary for the preservation of the fishery.

Early in 1928, the Commission reported its findings to the two governments and recommended: the limitation of the catch in the different sections of the coast, according to their individual needs and the annual reduction of the limits until the decline which was taking place in each section should cease; the extension of the closed season with provision for its adjustment

should this prove advisable; the prohibition of fishing gear deemed unduly destructive of small unmarketable fish; the licensing of fishing vessels for purposes of treaty, including the collection of compulsory statistical returns; and the closure to halibut fishing of areas, proved to be populated by small immature halibut.

A new treaty between the United States and Canada, for the preservation of the halibut fishery of the northern Pacific Ocean and Bering Sea, was ratified on May 9, 1931. In this, power was given the Commission to make all the proposed regulations effective.

*Location:* Offices and laboratories in Fisheries Hall No. 2, University of Washington, Seattle, Washington, near the canal connecting Lake Washington with Puget Sound.

*Organization to which attached:* International, governments of Canada and the United States.

*Purposes:* Regulation of the halibut fisheries of the northern Pacific Ocean and Bering Sea to perpetuate the fisheries.

*Scop of activities:* Regulation of the fisheries by limitation of catch. Collection and analysis of biological statistics of abundance of the halibut from Bering Sea to California, to determine the effects of regulation. Investigation of the early life history, growth, migrations, reproduction, mortality, etc., as a basis for and a check on regulation. This involves study of the distribution and abundance of the eggs and larval stages and their drift with the ocean currents, to which study the Commission devoted a certain amount of time each year.

*Equipment:* Laboratory and storage space sufficient for a staff of fourteen at Fisheries Hall No. 2. A library which has been recently begun and now contains approximately 1,000 volumes. This library is of a highly specialized nature, concerning itself mainly with fisheries literature pertinent to the various phases of the investigations of the Commission, since the nearby University of Washington library is well equipped for general fishery work. Whenever necessary for field work, a vessel suitable for operations in the open sea is chartered.

*Staff:* Commissioners: Chairman, George J. Alexander, A. J. Whitmore, Edward W. Allen, Frank T. Bell.

Scientists: Director of Investigations, William F. Thompson; Ass't. Director, age, growth, etc., Harry A. Dunlop; Biological statistics, market

measurements, etc., F. Howard Bell; Early life history, abundance and distribution of eggs and larvae, Richard Van Cleve; Migrations, mortality, etc., John L. Kask.

Others: 2 scientific assistants, 2 clerical assistants, 3 statistical assistants, 1 librarian.

*Provision for visiting investigators:* There are no provisions for visiting investigators.

*Income:* By annual appropriations, United States and Canadian. This has varied from \$30,000 to \$60,000 according to the amount of field work which must be done. Normally between 40 and 50 per cent of the appropriation is for vessel charter.

*Provision for publication of results:* Besides progress reports published by the fisheries services of United States and Canada, the Commission has published (1) scientific reports of which numbers 1-11 have already been issued, and (2) circulars with popular digests and statements, of which numbers 1-4 have been issued.

#### International Hydrographic Bureau ('37)

*History or origin:* The International Hydrographic Bureau was created in 1921 and established its seat at Monaco. The objects of its work may be summarized in the words:—"to make navigation easier and safer in all the seas of the world."

The following 21 maritime states became members: Argentine, Belgium, Brazil, British Empire: Great Britain and Australia, Chile, China, Denmark, Egypt, France, Greece, Italy, Japan, Monaco, Netherlands, Norway, Peru, Portugal, Siam, Spain, Sweden, United States of America.

The Governments of Belgium, Germany, Italy, Netherlands, and Peru have since withdrawn and Greece is no longer a member, but Ecuador, Poland, and Uruguay have become members and thus the Bureau is now supported by the governments of 19 maritime States.

The Principality of Monaco was selected as the seat of the Bureau largely because of its position on the sea, its central location, its excellent communications with the rest of the world and also because of the interest taken by the late Prince Albert I. of Monaco in all questions connected with the sea.

The Government of Monaco offered in 1927 to erect a building specially for the Bureau, with the sole proviso that the Bureau would remain therein for not less than 25 years. This very gracious offer was accepted by the States mem-

bers, and in April, 1929, the cornerstone of the building was laid by Prince Louis, with appropriate ceremony, in the presence of the delegates to the First Supplementary International Hydrographic Conference then in session.

On the 14th of January, 1931, the International Hydrographic Bureau was installed, with appropriate ceremony, in the handsome and convenient building on the Quai de Plaisance of the harbour of Monaco, by H. S. H. Prince Louis II. of Monaco, accompanied by the Hereditary Princess, the Minister of State, and most of the officials, both native and foreign, in the Principality.

The Bureau is supported by yearly contributions from the States members, based on each State's total combined naval and mercantile tonnage. Each State member has one vote on technical and administrative questions, but for the election of the directors and secretary-general the number of votes allotted to each State is based on the same tonnage figure as that which determines its contribution.

The Bureau having been established after the Treaty of Versailles (the majority of the members being members of the League of Nations), it was necessary, as well as desirable, for the Bureau to be affiliated with the League, but it is completely and entirely autonomous.

Under the statutes of the Bureau its work is conducted by a Directing Committee, chosen by the vote of the members, consisting of three Directors elected for a period of five years, and by a Secretary-General also elected for a term of five years assisted by a staff of technical and administrative assistants. The first Directing Committee and Secretary-General were:

Directing Committee: President, Admiral Sir John F. Parry, K. C. B. (Great Britain); Members, Rear-Admiral J. M. Phaff, (Netherlands) and Captain S. H. Müller (Norway).

Secretary-General: Commander G. B. Spicer-Simson, D. S. O.

Had it not been for the unfortunate death of Monsieur Renaud, who was a renowned French hydrographer and who originated the idea of the creation of the Bureau, he would undoubtedly have been selected as a member of the first Directing Committee. The President is the director who receives the highest number of votes.

A Hydrographic Conference is held at Monaco every five years at which all questions connected

with hydrography are discussed and the report of the work carried out by the Bureau since the previous conference is considered as also is the financial statement. At the end of the conference voting takes place for electing the three Directors and the Secretary-General for the next five years.

*Location:* Monte Carlo, Principality of Monaco.

*Organization to which attached:* International, 19 adhering countries.

*Purposes and scope of activities:* The statutes prescribe that the principal work to be undertaken by the Bureau is the following:

The study of documents published by hydrographic offices;

The drawing up and publication of various lists, such as of geographical positions, abbreviations and conventional signs used on charts, etc.;

The study of methods of hydrographic surveying;

The study of methods employed for the production of the results of surveys for publication;

The study of the construction and use of hydrographic instruments and appliances;

The study of the methods of recruiting and training personnel for surveying vessels and hydrographic offices;

The making of researches on any other subjects which affect hydrography;

Reports on the results of such studies and research, which appear to be of general interest, are published in French and English.

In general it may be stated that the International Hydrographic Bureau not only links the various hydrographic offices of the different States, but it is a sort of "clearing house" for all hydrographic information.

The Bureau satisfies, as far as possible, all requests for information or advice in connection with hydrography addressed to it by a member, and gives considered opinions on all questions dealing with its work which are referred to it by conferences or by scientific institutions.

Among the most interesting phases of the work recently undertaken by the Bureau is the collation and plotting of all deep sea soundings obtained. This is being done in order to keep the General Bathymetric Chart of the Oceans up-to-date.

The Bathymetric Chart was originally drawn up, at the suggestion of the Seventh International Geographical Congress held at Berlin (Germany) in 1899, by H. S. H. the Prince of Monaco. The first edition of the chart was communicated to the Eighth Congress at New York on September 13, 1904. Before drawing it up, however, Prince Albert I. had taken the advice of a committee

set up by the Seventh Congress to elaborate a terminology to be employed in describing the forms of the relief of the ocean bottom. This committee consisted of Baron von Richthofen, Chairman, Professors Krümmel, Pettersson, Supan, Thoulet, Doctors Hugh Robert Mill and Nansen, and Admiral Makaroff; and it met at Wiesbaden (Germany) in April, 1903. It was at this meeting that Prince Albert offered to draw the chart and meet all the expenses connected therewith. In 1912 a second and up-to-date edition was commenced, but it was not until 1930 that this was completed. Meanwhile, unfortunately, Prince Albert died and, though he had made provision for the completion of the second edition, no funds existed to carry on the valuable work. However, in April, 1929, the First Supplementary International Hydrographic Conference decided that this should be done by the International Hydrographic Bureau.

The use of original charts, instead of reprints by foreign nations, has long been held advisable, and one of the purposes of the Bureau is to help realize this aim. Naturally, this could not be attempted unless the signs, symbols, and abbreviations on all charts all over the world were standardized. This question has been discussed in detail at all the International Hydrographic Conferences, and gradually more and more of the symbols in common use have been standardized by the various hydrographic offices. In order to facilitate this, the Bureau has prepared a synoptic table showing the various symbols and abbreviations in use by the different countries. In spite of the desire of practically all hydrographic offices to conform to a standard set of signs and symbols, the realization of this aim still lies in the distant future owing to the excessive cost of making changes on existing charts. The best which can be hoped, under these conditions, is that, with the issue of new charts, the symbols adopted at the conferences will gradually be substituted for the old symbols.

The International Hydrographic Bureau has prepared also a synoptic table showing the signs, symbols, and abbreviations in use by the various hydrographic offices which publish charts for aerial navigation. This table was then turned over to the International Committee on Aerial Navigation, where it was made the basis of a study by the delegates to a conference on aerial navigation. Fortunately, as but few hydro-

graphic offices had started the publication of charts for coastal aerial navigation, there is great hope of early standardization, which will obviate the confusion which prevailed owing to the multiplicity of symbols formerly in use on marine charts.

From the above it will be seen that the International Hydrographic Bureau, although created with the principal object of coördinating the work of the hydrographic services of its members and to establish a close and permanent association between them, has as its main object the improvement of navigation and thus should appeal to all those who "go down to the sea in ships."

*Equipment:* Offices and library, especially a large collection of charts.

*Staff:* Directing Committee: President, Vice-Admiral J. D. Nares, D.S.C. (Retired) (Great Britain); Members, Rear-Admiral W. S. Crosley, U. S. Navy (Retired), Ingénieur Hydrographe Général de réserve P. de Vanssay de Blavous (France); Secretary-General, Vacant.

*Provisions for visiting investigators:* Members may temporarily attach an official to the Bureau for study or obtaining information.

*Income:* 169,600 gold francs (about \$56,500) at the moment.

*Provision for publication of results:* The following are the regular publications of the Bureau:

#### *Annual Report*

This contains a general report on the administration and work of Bureau.

#### *Special Publications*

These publications are issued at irregular intervals and contain information which is likely to be of more than passing interest. Some of them contain tables which are of permanent interest.

#### *Hydrographic Review*

The first number was issued in March 1923, but in 1924 and thereafter this publication has been issued twice annually, in May and November, except in 1926 when one number only was issued (in July). Each volume consists of two numbers, which are themselves fair-sized books, containing from 200 to 300 pages. The contents are very varied and include articles by authorities of many nations, dealing with nearly every aspect of hydrography and with many allied sciences in so far as they affect hydrography. It is an organ for free discussion and exchange of views between hydrographic surveyors and it contains a bibliography of hydrographic publications.

*International Hydrographic Bulletin*

This publication has been issued each month commencing in January, 1928, until January, 1934, since when it has been issued every two months. It contains information which may be important but is of ephemeral interest only.

*Year Book*

This is published annually, commencing in January, 1928. It gives the titles, addresses, etc., of hydrographers, information as to hydrographic offices, a list of surveying vessels with their tonnage, etc., for the whole world, so far as such information has been communicated to the Bureau, besides other information of interest to seamen. In addition to the above, the Bureau has published:—

*Reports of Proceedings of the International Hydrographic Conferences:*

- 1st Conference, London, 1919.
- 2nd Conference, Monaco, 1926.
- 1st Supplementary Conference, Monaco, 1929.
- 3rd Conference, Monaco, 1932.

*The Statutes of the International Hydrographic Bureau, 1926.*

By these means the International Hydrographic Bureau disseminates information on subjects pertaining to hydrography and navigation. The International Hydrographic Bulletin contains information of immediate interest and importance. It includes also a list of all recent hydrographic documents and publications received from the various hydrographic offices of the world, and directs attention to matters of urgent importance. The semi-annual Hydrographic Review, published in both French and English, contains monographs of general interest to hydrographers and navigators, important articles translated from foreign publications and descriptions of new methods and instruments in use in the various countries. In this manner each hydrographic office is enabled to keep in touch with the methods in use and work being done by the other hydrographic offices; this should tend to lead gradually to an improvement in the methods in use, besides helping to bring about uniformity in hydrographic documents and publications.

In general it has been found, at the International Hydrographic Conferences, that all countries are anxious to bring about that uniformity in hydrographic documents and publications which is so greatly to be desired. Possibly the greatest hindrance to the realization of this

ideal is the ever present question of cost and, while it may be relatively easy to obtain agreement regarding some questions, in others the cost of making the changes involved is almost prohibitive.

The International Hydrographic Bureau has to its credit a long list of accomplishments which will certainly do much to make navigation easier and safer. Amongst these may be noted: the universal adoption of compass graduation from 0° to 360°, the standardization of numerous signs and symbols in use on marine charts, the establishment of central offices at various ports for the exhibition of notices to mariners, as well as the publication of numerous *Special Publications* on technical subjects, which include: 4 on echo sounding, 2 on visibility of lights, 3 on uniformity of buoyage, 2 on data on uniformity in storm warning signals, and one on each of the following:

- International Low Water.
- Data on Wind Force and the Beaufort Scale.
- Investigation of Harmonic Constants; prediction of tides and currents and their description by means of these constants.
- Tide predicting machines.
- Data on coastal signals, with proposals for their unification.
- Data on port signals.
- List of life-saving stations.
- Ocean currents in relation to oceanography, marine biology, meteorology, and hydrography.
- Summary of data on safety of life at sea.
- General list, arranged by oceans, and historical cards of shoals of doubtful existence and of shoals the positions of which are doubtful or approximate.
- Table of Meridional parts.
- Manual of symbols and abbreviations.
- Limits of oceans and seas.
- Oceanographical positions.
- Catalogue of original charts (in two parts).
- List of nautical documents issued by hydrographic offices.
- Planisphere.
- List of tidal harmonic constants.
- Reproduction of Mercator's chart, 1569.
- Vocabulary concerning tides.
- Vocabulary concerning fog signals.

All publications of the Bureau, including the Bathymetric Chart, are on sale to the public.

#### International Service of Ice Observation and Ice Patrol in the North Atlantic Ocean ('37)

*History or origin:* At the International Conference on the Safety of Life at Sea, which was convened in London on November 12, 1913, the subject

of patrolling the ice regions in the vicinity of the Grand Banks of Newfoundland along the trans-Atlantic steamship lanes, where in the spring and early summer icebergs form a menace to navigation, was thoroughly discussed, and the convention signed on January 20, 1914, by the representatives of the various maritime powers of the world provided for the inauguration of an international service of ice observation and ice patrol in the North Atlantic Ocean. The Government of the United States was invited to undertake the management of this service, the expense to be defrayed by the powers interested in transatlantic navigation in a fixed proportion, which was definitely agreed upon, subject to ratification by the law-making bodies of the governments concerned.

As the convention when ratified would not go into effect until July 1, 1915, the Government of Great Britain, on behalf of the several powers interested, made inquiry on January 31, 1914, as to whether the United States would be disposed to undertake at once this international service under the same mutual conditions and obligations as provided in the convention. The proposition was favorably considered by the President, and on February 7, 1914, he directed that the Coast Guard begin as early as possible in that month the international service of ice observation and ice patrol. Each year since then, with the exception of the World War years 1917 and 1918, ice observation studies, oceanographic investigations, and a service of ice patrol has been carried on by the United States Coast Guard. It is a matter of national pride that since this duty was assumed by the Coast Guard there has not been a life lost in the area being patrolled.

The International Conference on Safety of Life at Sea, signed at London on May 31, 1929, made provision for the continuance of this international service along the same general lines as provided for in the Convention of January 20, 1914. The Congress of the United States, by Act approved June 25, 1936, following the ratification of the International Convention by the United States, provided by law for the conduct of this International Ice Observation and Ice Patrol Service by the United States Coast Guard.

*Location:* North Atlantic Ocean and Davis Strait.

*Organization to which attached:* United States Coast Guard.

*Purposes:* Safety of life at sea, and furtherance of

knowledge of ice conditions and oceanography in the North Atlantic and Davis Strait region.

*Scope of activities:* Briefly stated, the duties of the Coast Guard in conducting the Ice Patrol consist in finding and keeping in touch day by day with icebergs and field ice, determining their set and drift, reporting their presence and location to the Hydrographic Office of the Navy, and broadcasting the information by radio for the protection of shipping. The Coast Guard cutters while on this work also perform such incidental service, not to interfere, however, with the paramount duty of the patrol, as rendering assistance to vessels in distress, giving medical aid to crews of passing vessels, removing obstructions to navigation, and extending such other assistance to the mariner as may be practicable.

Scientific observations are made of the ocean currents, their direction and rate of flow; salinity content of the water; bathymetry; and upper air currents; and such other observations and experiments for the aid and furtherance of oceanographic knowledge, particularly with relation to ice conditions in the North Atlantic Ocean, as might be deemed advisable and feasible.

*Equipment:* Normally three vessels are detailed from the regular Coast Guard organization for the duty of ice observation and ice patrol during the ice menace season. During the balance of the year scientific cruises are planned and conducted by one vessel when the need for such observations are necessary or advisable.

*Staff:* One commissioned officer and one senior physical oceanographer specialize in the scientific work associated with the International Service of Ice Observation and Ice Patrol. This duty is carried on as a part of the prescribed work of the United States Coast Guard, and the administrative and operating forces of the Coast Guard are utilized to such extent as may be necessary for the proper and efficient conduct of this international service.

Scientific (permanent members)

Mr. Floyd M. Soule, Senior Physical Oceanographer.

The commissioned officer assigned as ice observation officer serves on such detail for usually about three years when he is relieved by another commissioned officer of the Coast Guard.

*Provisions for visiting investigators:* None.

*Income:* Provision for the conduct of the International Service of Ice Observation and Ice Patrol

is made by appropriations by the Congress of the United States. No specific appropriation is made, the appropriations made for the conduct of the United States Coast Guard being utilized as may be necessary and when available. Reimbursement is made to the United States Government for the expense of maintaining and operating the International Service of Ice Observation and Ice Patrol by the interested governments, signatory to the International Convention for the Safety of Life at Sea, and in the proportionate amounts specified in the International Convention.

*Provision for publication of results:* Each year the Coast Guard publishes a Bulletin giving a full report of the operations of the International Service of Ice Observation and Ice Patrol during each ice season, and containing a comprehensive and detailed account of scientific observations made. Occasionally, bulletins are issued dealing with scientific subjects bearing upon observations and investigations of the International Service of Ice Observation and Ice Patrol.

#### **North American Council on Fishery Investigations ('37)**

*History or origin:* In the spring of 1920, the Canadian Government took up with the governments of the United States and Newfoundland, the matter of the establishment of some coöperative arrangement between the countries of the western North Atlantic for the investigation of those fisheries problems of interest to the countries concerned. The governments of both the United States and of Newfoundland concurred with the Canadian Government in the view that coöperative action was desirable and on September 23, 1920, fishery experts representing the three governments mentioned met at Ottawa on the invitation of the Canadian Government. This conference unanimously adopted the following resolution which was subsequently approved by the respective governments.<sup>4</sup>

"BE IT RESOLVED, that it is the sense of this meeting that, on the nomination of the fishery services of the countries represented, each of the respective Governments should forthwith designate three persons to constitute an International committee on marine fishery investigations, this committee to determine what measure of International coöperation is desirable, what

general investigations should be undertaken, consider definite problems that may be awaiting study, submit recommendations to their respective Governments, and coördinate and correlate the results of the work.

It is the expectation that the respective Governments will undertake to provide the necessary ways and means for conducting such independent and coöperative investigations as may be adjudged desirable by the International Committee.

It is recommended that the International Committee establish contact with the Permanent International Council for the Exploration of the Sea."

In 1922 France, because of her important fisheries in the western North Atlantic and her pursuit of scientific investigations relating to them, requested representation on the committee and her request was approved.

*Location:* The Council has no specific place of meeting but selects a place in accordance with the desires of its members.

*Independent organization* composed of representatives nominated by the fisheries services of the four countries concerned.

*Purposes:* The principal objectives accomplished by coöperative effort in coöordinating the work of the several Governments have been: (1) to provide more complete fishery statistics of the offshore fisheries; (2) to correlate and encourage investigations of the fisheries resources in which the member nations have a common interest; and (3) to accumulate data on the oceanographic conditions and their relationship to fish life, including drift-bottle experiments, records of water temperatures, etc. These phases of the work of the council are developed in greater detail hereafter.

The council has given incidental consideration to many other problems which have arisen from time to time but has centered its activities on the subjects mentioned. The council has approved the establishment of informal contacts between it and the International Council for the Exploration of the Sea and the International Geodetic and Geophysical Union, for the purpose of exchanging information.

*Scope of activities:* In the copy of the first number of the published Proceedings of the Council, the work of the United States is reported under captions as follows: Fishery statistics, Cod investigations, Mackerel investigations, Haddock investigations, and Hydrological investigations.

The work of Canada is reported under the captions: Fishery statistics, Cod fishery, Haddock fishery, Mackerel fishery, Water circulation,

<sup>4</sup> North American Council on Fishery Investigations, Proc. 1921-1930, no. 1, 1932.

Water temperatures, and Passamaquoddy power project.

The work of Newfoundland is reported under the following captions: Fishery statistics, Cod fishery, Water circulation, and Water temperatures.

The work of France is reported under the captions: History of the investigations made at Newfoundland, Hydrological system of the Newfoundland region, Relation between the hydrological phenomena off Greenland and those of the Newfoundland region, Remarks on the fauna of the Newfoundland Banks, Bottom fauna, and Mapping.

In the second number of the published proceedings of the Council the general captions for the combined work of the Council are as follows: Coöperation with the International Council for the Exploration of the Sea, International Passamaquoddy Investigations, Fishery Statistics, and Hydrography.

There is a report for each of the adhering countries with captions as follows:

United States: Mackerel investigations, Haddock investigations, Cod investigations, Fishery statistics, Hydrological investigations, and Woods Hole Oceanographic Institution, which reports on hydrography, drift bottles, plankton, mackerel, and haddock.

Canada: Cod investigations, Haddock investigations, Salmon investigations, Herring investigations, Fishery statistics, Bait investigations,

Water temperature, Hydrological investigations, and Plankton investigations.

Newfoundland: Hydrological investigations, Surface drift bottles, Plankton investigations, Bait-fishes and squid, Salmon investigations, Cod investigations, and Haddock investigations.

French investigations at Newfoundland and Greenland in 1931, 1932, and 1933: Observations made in 1931 in Greenland, Investigations carried on in 1932, Investigations carried on in 1933.

*Equipment:* None.

*Officers:* The Council is composed of representatives nominated by the fisheries services of Canada, France, Newfoundland, and the United States. The Council selects its own chairman from among its members. The present members of the Council are as follows:

Canada: W. A. Found, J. P. McMurrich, A. G. Huntsman, Secretary.

France: Edouard LeDanois.

Newfoundland:

United States: F. H. Bell, Elmer Higgins, H. B. Bigelow, Chairman.

*Provisions for visiting investigators:* None.

*Income:* No special appropriation for the work of the Council.

*Provision for publication of results:* The results of the investigations conducted under the advice of the Council are published by the respective governments but two reports entitled "North American Council on Fishery Investigations," Proc. 1921-1930, No. 1, and 1931-33, No. 2, have been published by the Canadian Government.

# INSTITUTIONS, EAST SIDE OF THE ATLANTIC AND CONNECTING SEAS

## ALGERIA TO FRANCE, INCLUSIVE

### ALGERIA

#### Station Zoologique Maritime sur la Jetée Nord (Alger) ('34)

*History or origin:* Founded in 1888 by Dr. Camille Viguier (March 16, 1890, to February 17, 1930.)

*Location:* City of Algiers.

*Organization to which attached:* Faculty of Sciences of the University of Algiers, to the laboratory of General Zoology.

*Purposes and scope of activities:* Research in marine biology. Licencié students (with certificates of higher studies in general zoology) come for practical work and to initiate themselves in the study of marine animals.

*Equipment:* Working laboratory.

*Staff:* Director, L. G. Seurat; Professor, M. Rose; Chief of Works, H. Gauthier; Preparator, Dr. R. Dieuzeide.

*Provisions for visiting investigators:* Foreign investigators after correspondence with the director may have the facilities of the laboratory extended to them.

*Provision for the publication of results:*

#### Station d'Aquiculture et de Pêche de Castiglione ('34)

*History or origin:* Established in 1921 by Professor Bounhiol. The building was erected behind the boundary of the maritime public domain.

*Location:* At Castiglione, 47 kilometers west of Algiers. Area, 1 hectare.

*Organization to which attached:* The General Government of Algeria.

*Purposes and scope of activities:* Laboratory of marine biology applied to fishes. Investigation of migratory fishes, the exploration of the sea, plankton, and marine faunas; fishery investigations, fishing gear, the capture of fishes, tuna fishery, preservation, and the study of fishery products.

*Equipment:* Laboratories, 2 aquaria, room for glass working, fishing gear, refrigeration installation to

—30° for the study of freezing fish. A water tower 19 meters high enables the delivery under pressure of both fresh and salt water. In addition, in the park of the establishment there are several basins of fresh water for the cultivation of several species of fishes useful in the fight against mosquitoes. Library.

*Staff:* Director, Professor L. G. Seurat; Head of the Station, Dr. R. Dieuzeide.

*Provisions for visiting investigators:* Foreign workers are admitted for researches in marine biology at the Station after agreement with the director. A special laboratory is at their disposal and there are guest rooms.

*Provision for the publication of results:* Since 1926 two fascicles are published annually of "Bulletin des Travaux de la Station Experimentale d'Aquiculture et de Pêche de Castiglione." Fourteen fascicles have been issued.

### BELGIUM

#### Royaume de Belgique, Service de l'Hydrographie ('37)

*Location:* 90, rue de la Loi, Brussels.

*Staff:* Head of Scheldt Hydrographic Office (Acting), Ingénieur Principal des Ponts et Chaussées J. J. Blockmans; Head of Coast Hydrographic Office, Hydrographe-Adjoint Principal J. A. P. Lauwers.

*Equipment:*

SURVEYING VESSEL	DISPLACEMENT	OFFICERS	CREW
VICTOIRE.....	242	2	6
BOUILLON.....	100	1	6

#### Institut Maritime de Belgique at Ostend ('37)

*History or origin:* Established about 1900 in quite a rudimentary condition. Reorganized in 1935. Buildings under construction.

*Location:* Ostend, on the Belgian sea-front, at the entrance of Ostend Harbor.

*Organization to which attached:* Autonomous institution under supervision of the government. Subventions obtained from various ministries. Declared Institution of Public Utility. Connected with the Musée Royal d'Histoire naturelle of Brussels.

*Purposes:* To make an intensive biological survey of the waters adjacent to the Belgian coast and the Mer Flamande. Investigations on fisheries in the southern part of that sea.

*Scope of activities:* Exploration of the sea bottom, observations on temperature, salinity, etc., investigations on fishes, plankton, organisms of the coastal zone; trawling; dredging.

*Equipment:* Small laboratory; study aquaria with sea-water circulation; biological library. The new building will be provided with general and private working rooms. A public aquarium is contemplated. Vessels provided by the Ministère des Transports, Administration de la Marine.

*Staff:* Director, Professor G. Gilson of the University of Louvain. (Internal organization not yet arranged.)

*Provisions for visiting investigators:* Working places in the laboratory and materials provided as far as possible. No lodgings.

*Income:* Not yet fixed.

*Provision for the publication of results:* Annales de l'Institut Maritime de Belgique. Three memoirs have been published.

#### CZECHOSLOVAKIA

**Geographical Institute of the Charles University in Prague (Geografický ústav Karlovy university, Praha, Československo; L'Institut de Géographie de l'Université Charles IV, Prague) ('36)**

*History or origin:* The Charles University is the oldest University of Central Europe, founded in 1348. Oceanographic research has been carried on for five years, lectures on physical and anthropological oceanography have always been included in the program.

*Location:* Prague II, Albertov 6, Czechoslovakia (Praha II, Albertov 6, Československo; Prague II, Albertov 6, Tchécoslovaquie).

*Organization to which attached:* Charles University, of which the Institute is a department.

*Purposes:* Instruction in oceanography as part of the general instruction in geography. Research.

*Scope of activities:* Researches in physical oceanography with lectures in physical and human

oceanography. Biological oceanography is carried on separately in the departments of plant and animal physiology. Marine bottom deposits are studied in the geological, mineralogical, petrographical, and paleontological departments.

*Equipment:* The Institute occupies the second floor of the Science Building with a floor-space of 1750 square meters, and has 750 and 114 square meters of laboratories under the roof, altogether the Institute occupies 2614 sq. meters. The Library of the Institute has more than 25,000 volumes, including a rich collection of oceanographic books. The collection for the Polar Seas is one of the richest in Europe. Well equipped is the collection of Admiralty Charts of various states. The Institute owns equipment for small oceanographic and limnological researches.

*Staff:* Prof. V. Švambera, Director, lecturer on Polar Seas and physical oceanography.

Prof. B. Šalamon, lecturer on the geophysics of the ocean.

Prof. V. Dédina, lecturer on the geomorphology of the recent and former ocean basins and their coasts.

Prof. F. Štůla, lecturer on oceanography in general with special regard to economic geography.

Dr. V. J. Novák, lecturer on the geophysics of the ocean.

Dr. J. Kinský, research and lecturer on the special geomorphology of the ocean basins and their coasts.

Dr. J. Moschelesova (Miss), lecturer on human oceanography.

Dr. K. Kuchař, cartographer and lecturer on cartography.

Dr. J. A. Zukriegel, research in physical oceanography and chemistry, sea-ice researches. 5 clerical assistants.

2 maintenance and operation workers.

*Provisions for visiting investigators:* The Institute and Library are open to all students of geography of Charles University, at present about 200.

*Income:* State Institute with paid staff and a regular annual income from the State of 40,000 Kč for books, charts, and instruments.

*Provision for publication of results:* The Institute is publishing a series entitled "Travaux géographiques tchèques." The members of the staff also publish papers in various scientific periodicals at home and abroad.

**Biological Station at Rab, Isle Rab, Dalmatia,  
Yugoslavia ('34)**

*History or origin:* Founded in 1930 by "Rab," Czechoslovak Society of Marine Biological Station.

*Location:* Rab, Isle Rab, Dalmatie, Yugoslavie. Building "Komensky."

*Organization to which attached:* The above-named Society, which is composed from the staff of several Czechoslovak universities and other high schools.

*Purposes:* Czechoslovakia has no sea, it is thus necessary to profit from the hospitality of Yugoslavia. General purpose: to enable Czechoslovak biologists to work in sea biology.

*Scope of activities:* Description of local fauna and flora, cataloging its seasonal occurrence. Histological, cytological, physico-chemical research. Installation of local biological museum.

*Equipment:* Elementary equipment for microscopy, elementary general laboratory equipment, sensitive galvanometer. For the present no gas, no electric current. 2-3 working places, 1 room. Special apparatus and chemicals should be provided by the visitors.

*Staff:* No permanent staff. Administration of the Station is in the hands of the Society: President, Prof. B. Němec, Prague; Secretary, Prof. J. Bělehrádek, Brno.

Only advanced workers are admitted and only members of the Society, except introduced guests.

*Provisions for visiting investigators:* Gratuitous bedroom and food for 2 members of the Society. Otherwise 10% reduction in local hotels Praha and Bristol (proprietor A. Machár, member of the Society).

*Income:* Source: From private sources, sale of specimens, annual memberships. Equipment maintained and enlarged chiefly by donations from Czechoslovak university laboratories and laboratory utensil houses.

Amount: Small, irregular.

*Provision for publication of results:* Workers are obliged to furnish to the Society reprints of papers published in various periodicals. First volume of "Travaux" for 1930-32 to be sent for exchange in the autumn 1933 from the secretary.

**DENMARK**

**Dansk Biologisk Station (The Danish Biological  
Station) ('37)**

*History or origin:* Established in 1889. C. G. Joh. Petersen was the first Director, succeeded by

A. C. Johansen 1926 and by H. Blegvad 1932. In 1936 the Laboratory was transferred to the old castle "Charlottenlund Slot," facing the Sound and about 8 kms. north of the center of Copenhagen.

*Location:* Charlottenlund Slot, Copenhagen, and Nyborg (at the bottom of a small Danish Fjord).

*Organization to which attached:* Ministeriet for Landbrug og Fiskeri (Ministry of Agriculture and Fisheries).

*Purposes:* Marine and fresh water investigations with special regard to fisheries.

*Scope of activities:* Researches in biology of marine and fresh water organisms, especially fishes; chemical and physical investigations of sea and freshwater; valuation of sea bottom; transplantation of fish; output of artificially reared fry; marking experiments.

*Equipment:* A main Laboratory in Charlottenlund Slot. A floating laboratory at Nyborg with service buildings and accommodations for aquaria. A freshwater laboratory at Frederiksdal, Lyngby. A research steamer BIOLOGEN, 143 tons, for investigations in Danish home waters.

*Staff:* Scientific: Director, Dr. Phil. H. Blegvad, 1 permanent assistant, Dr. Phil. Erik M. Poulsen, 2 research assistants, Mag. Sc. C. V. Otterstrøm, Cand. S. W. Fogh. Clerical and operation: 1 clerk, 1 librarian, 8 research steamer crew.

*Provisions for visiting investigators:* 2 or 3 work places either at the laboratories or on board the research steamer.

*Income:* Source: From the Danish Government. Amount: about 110,000 Kroner for 1936-37.

*Provision for publication of results:* Report of the Danish Biological Station I-XXXVII, 1890-1931.

**Kommissionen for Danmarks Fiskeri- og Havundersøgelser (The Danish Committee for Fisheries Investigations and the Study of the Sea) ('37)**

*History or origin:* In Denmark the "Kommissionen for Havundersøgelser" (The Commission for Investigations of the Sea) was created in 1902; its purpose was to secure the execution of Denmark's part of the investigations planned by the International Council for the Exploration of the Sea. Chairman of the Commission was Dr. C. G. Johs. Petersen, the Director of the Danish Biological Station; the other members were Capt. C. F. Drechsel, Doctor C. H. Ostenfeld, and Dr. Martin Knudsen.

In the year 1909 Doctor Petersen withdrew

from the Commission and Dr. Johannes Schmidt, Dr. A. C. Johansen, and Inspector of Fisheries F. V. Mortensen, became members; Capt. C. F. Drechsel was chairman. In 1925 C. F. Drechsel withdrew and F. V. Mortensen, Director of Fisheries, became chairman. The Commission was reestablished in 1926, and the name was altered to "Kommissionen for Danmarks Fiskeri- og Havundersøgelser"; two representatives elected by the Fishermen's organization entered the Commission: M. C. Jensen, M.P., and Axel Henriksen; Professor C. H. Ostenfeld was succeeded by Professor Ove Paulsen in 1931; Dr. A. C. Johansen in 1931 by Dr. H. Blegvad; and Professor Johs. Schmidt by Dr. Å. Vedel Tåning in 1933. In 1935 Director of Fisheries F. V. Mortensen resigned as chairman of the Committee and Director of Fisheries C. Trolle-Thomsen became chairman.

*Location:* Charlottenlund Slot, an old castle facing the Sound and about 8 kms. north of the center of Copenhagen.

*Organization to which attached:* Ministeriet for Landbrug og Fiskeri (Ministry of Agriculture and Fisheries).

*Purposes:* Fisheries investigations and general marine biological and hydrographical investigations.

*Scope of activities:* Researches on the biology of fishes, especially with reference to commercial fisheries; phyto- and zooplankton; marine benthos and bottom deposits; physics and chemistry of sea water; general researches in oceanography.

*Equipment:* Laboratory building, 4 floors; annexed buildings for collections, public exhibition, stock of publications, etc. Research vessel DANA III, launched January 9, 1937, for the North Sea and Atlantic investigations; about 400 tons, diesel motor ship.

*Staff:* Chairman of the Committee: Director of Fisheries C. Trolle-Thomsen.

*Hydrographical Laboratory:* Prof. Dr. Martin Knudsen, Director; Dr. J. P. Jacobsen, Magister Helge Thomsen; 2 technical assistants.

*Plankton Laboratory:* Prof. Dr. Ove Paulsen, Director; Dr. P. Jespersen, Dr. E. Steemann Nielsen.

*Fisheries Laboratory for the investigations in the Danish waters:* Dr. H. Blegvad, Director; Dr. Åge J. C. Jensen; 1 clerical and 2 technical assistants.

*Marine Biological Laboratory for the investigation in the North Sea, Faroese and Icelandic waters:* Dr. Å. Vedel Tåning, Director; 3 clerical and

technical assistants. With the Laboratory for the investigations in the North Sea, Faroese and Icelandic waters is connected "*Carlsberg-fondets DANA Ekspeditioner*" consisting of the oceanic collections from the DANA Expeditions. The Carlsberg Foundation defrays the expenses of this department and publishes a report on the results. Dr. Å. Vedel Tåning, Director; Dr. V. Ege, Dr. A. F. Bruun; 7 clerical and technical assistants.

*Provisions for visiting investigators:* Work places for foreign investigators can be provided in the laboratory and on the research vessel.

*Income:* About 168,400 Danish Kroner from the Danish State for the financial year 1936-37; 25,000 Danish Kroner from the Carlsberg Foundation for the oceanic collections "*Carlsberg-fondets DANA Ekspeditioner*."

*Provision for publication of results:* "Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser." "Skrifter fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser." "DANA-Report" of the "Carlsberg Foundation's oceanographical Expedition round the world 1928-30 and previous DANA-Expeditions."

#### Kongelige Søkort-Arkiv (Royal Nautical Chart Archives) ('37)

*Location:* Toldbodvej 19, Copenhagen.

*Staff:* Hydrographer, Kommandør Kaptajn P. C. S. Jensen.

Head of 1st Section (Surveys) Kaptajnløjtnant C. H. A. Madsen.

Head of 2nd Section (Notices to Mariners and Sailing Directions), Kaptajn C. C. Zieler (ret'd).

Head of 3rd Section (Instruments, calculations, etc.). Orlogskaptajn O. Pade, R.N.R.

Head of 4th Section (Surveys, Danish waters) Kaptajnløjtnant E. J. Saabye.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
MARSTRAND.....	172	3-4	24
HEIMDAL.....	900	9	38

#### EGYPT

#### Laboratoire des Recherches sur les Pêcheries ('34)

*History or origin:* Recent, building finished in 1931.

(See: Mémoire sur l'Organisation des Recherches des Pêcheries, Ministère des Finances, Direction des Recherches des Pêcheries, Notes et Mémoires, no. 1, 1933.)

*Location:* Kayed Bay within the City of Alexandria

upon the probable site of the ancient Ptolemaic Pharos.

*Organization to which attached:* Under the administration of the Coast Guard and Fisheries, Ministry of Finance.

*Purpose and scope of activities:* All researches needed in the study of the marine and fresh water fishes of Egypt. Taxonomy, classification, life histories, physiology and ecology of fishes, plankton, benthos, and hydrography (the physical and chemical properties of the water). Oceanographic cruises are contemplated.

*Equipment:* 4 small workrooms, a large common room, all provided with fresh and salt water and gas. The laboratory possesses instruments and material for biological and chemical work. It is always advisable for a visitor to give advance information regarding the things that he will need for his work.

A small library and a small museum are being formed.

1 ketch for collecting along the shore.

1 research boat 45 m long, the *MABAHISS*, was loaned by the Egyptian Government for the John Murray Expedition in the Indian Ocean, and for subsequent use in the Red Sea.

*Staff:* Director, Dr. Hussein Faouzi; 2 assistants.

*Provisions for visiting investigators:* Visitors can be received: the region to be investigated is very large, 2 seas, 5 large lagoons, Suez Canal with its series of large lakes, and the Nile.

*Income:* The laboratory budget is a part of the State budget.

*Provision for the publication of results:* Annual Reports on Fisheries and a series, Notes and Memoirs, of which two have already appeared and five are in press.

*Note:* Data on the Marine Biological Station at Ghardaqa are given under the *Red Sea and in India*. See page 219.

#### **Mawani Fanarat (Ports and Lighthouses Administration) ('37)**

*Location:* Alexandria.

*Staff:* Director General, H. E. el Lewa, G. A. Wells; Deputy Director General, El Lewa M. Hamdy el Deeb Pacha.

#### **ENGLAND**

#### **Fisheries Experiment Station, Castle Bank, Conway ('37)**

*History or origin:* Started in 1915 to deal with problems connected with shellfish pollution.

In 1931 was reorganized, with some augmentation of staff, under present title of "Shellfish Services."

*Location:* Laboratory and offices: "Castle Bank," Conway, Caernarvonshire, North Wales

Purification and experimental tanks, and branch laboratory: Benarth Road, Conway, Caernarvonshire, North Wales.

*Organization to which attached:* Ministry of Agriculture and Fisheries, London.

*Purposes:* The study of shellfish in general, with special reference to public health and economic problems.

*Scope of activities:* 1. In collaboration with the Ministry of Health, London, to combat the dangers arising from the pollution of shellfish.

2. The establishment at the chief shellfish-producing centers of shellfish purification plants similar to that in operation, during the last eighteen years, at Conway.

3. The carrying out of bacteriological surveys of polluted shellfish beds.

4. Experimental work designed to facilitate the establishment of an international standard method of bacteriological examination of shellfish.

5. Research into oyster breeding problems.

*Equipment:* 1 building containing bacteriological, biological, and chemical laboratories, offices, etc., 3 floors and basement.

The shellfish purification installations at Conway and Lymptone each consisting of storage and chlorinating tanks (capacity of each 90,000 gallons), and two treatment tanks (capacity of each 40,000 gallons). These tanks can be used in the summer season for shellfish research, notably large-scale oyster breeding experiments.

2 oyster breeding tanks (capacity of each 19,000 gallons).

2 uncovered, and 2 covered and heated, tanks (capacity of each 2,600 gallons) for research into the conditions necessary to achieve purification in oysters.

*Staff:* R. W. Dodgson, O.B.E., M.D. (London), M.R.C.P., M.R.C.S. Director of Shellfish Services.

Mr. H. P. Sherwood, M.C., B.S., assistant to the director (Naturalist).

Mr. H. A. Cole, M.Sc. (assistant naturalist).

Mr. J. P. Harding, B.Sc., M.A., Ph.D. (assistant naturalist).

Mr. E. M. Cartmel-Robinson, principal technical assistant.

Miss D. H. Campbell, technical assistant.

Mr. F. G. Phipps, laboratory assistant.

Mr. H. Lees, tank superintendent, Lymington, Devon.

Mr. H. Brown, tank superintendent, Conway, North Wales.

1 shorthand-typist.

*Provisions for visiting investigators:* Provision is made, by arrangement, for visiting investigators.

*Income:* From State. Maintenance expenses, approximately £750; salaries £3,430.

(N.B. There is a set-off against the expenses of the station of about £650 per annum in respect of fees paid for cleansing mussels for the market.)

*Provision for publication of results:* Contributions are made to the Ministry's Fisheries Investigations, Series II, Sea Fisheries, and pamphlets are issued from time to time dealing with shellfish matters.

#### **Dove Marine Laboratory ('37)**

*History or origin:* Established in 1897. The present building was constructed in 1908.

*Location:* On the sea front at Cullercoats, Northumberland, England.

*Organization to which attached:* Armstrong College, University of Durham. The Laboratory is a department of the College and is under the direction of the Professor of Zoology.

*Purposes:* Major purpose, research. Instruction in marine biology is also given to students of Armstrong College and of other Universities. Special instruction in different fields of biology may also be given.

*Scope of activities:* Research is carried out on local fishery problems, with special reference to herring and salmon; faunistic work; general biology and comparative physiology of fish and marine invertebrates; river pollution. The Laboratory is also visited by school children. Teachers are advised as to the conduct of classes in marine biology, and Easter classes are held at the Laboratory. The staff also gives lectures to various societies in the district.

*Equipment:* One laboratory building, 64 x 29 feet. The ground floor is given up to the aquarium with eleven large and thirty-eight small tanks for the supply of which fresh sea-water is pumped into storage tanks daily. On the first floor is a general laboratory divided into cubicles suitable for work which does not require much apparatus, a large room which has been recently fitted up specially for experimental work and is also

suitable for teaching and other purposes, a small chemical laboratory, and the library (two rooms).

One small, sound-proof hut for the study of problems of animals' behavior.

The Laboratory is equipped with apparatus for the conduct of research in most forms of research in general zoology, and comparative physiology.

The most important publications in marine biology are available either in the library of the station or in that of Armstrong College.

*Staff:* Director, A. D. Hobson, M.A. (Cantab.), F.R.S.E.; Naturalist, B. Storrow, M.Sc., A.L.S.; Biologist, H. O. Bull, B.Sc., Ph.D.; Librarian, Mrs. Cowan.

*Provision for visiting investigators:* About ten in addition to the staff of the station could be accommodated.

*Income:* Source: Grants from H. M. Development Commissioners, Armstrong College and various local sources, admission of public to aquarium and sale of specimens.

Amount for year ending March 31st, 1937, about £2,250.

*Provision for publication of results:* Dove Marine Laboratory Reports and scientific periodicals.

#### **Department of Zoology and Oceanography, University College, Hull ('37)**

*History or origin:* The Department of Zoology came into existence at the opening of the College in October, 1928, and in 1931 it was enlarged to a Department of Zoology and Oceanography. The new oceanographical laboratories were opened in December, 1931.

*Location:* At the University College of Hull, on the northern outskirts of the city.

*Organization to which attached:* University College of Hull.

*Purposes:* (Of oceanographic section of the Department.) Research, particularly in biological oceanography in relation to fisheries. A year's post-graduate course is offered in biological oceanography, intended particularly for students taking up work in relation to fisheries.

*Scope of activities:* At present (1936) the activities of the Department are being concentrated upon a survey of the changing plankton of the North Sea from month to month in relation to the fisheries by means of continuous plankton recorders worked on four different steamship lines across the North Sea and also by means of

smaller instruments—plankton indicators—used on commercial fishing craft. In addition researches into the biology of fishes and marine organisms in general are undertaken by post-graduate research workers.

*Equipment:* 6 research laboratories, preparation room, and office.

Small museum.

Library forming section of general College library.

Photographic dark room.

At present no research ship is employed, all the work at sea being carried out with special equipment on steamship lines and fishing craft.

*Staff:* Director, Professor A. C. Hardy, M.A. Research Biologists, G. T. D. Henderson, B.Sc., Ph.D.; C. E. Lucas, B.Sc.; K. M. Rae, B.Sc. Two maintenance workers.

*Provisions for visiting investigators:* Hull, while a great center of the fishing industry, is situated on the Humber and not on the sea coast proper, so that the department which is twelve miles from the sea does not offer facilities for the study of the coastal fauna and flora, which in the immediate vicinity are poor. The Department is concerned with the wider oceanographic problems of the North Sea and the Arctic Seas in relation to the fishing industry. Post-graduate research workers wishing to take part in such investigations are welcomed, and in addition the zoological laboratories, which are provided with marine aquaria, are equipped for all ordinary zoological research.

*Income:* In 1936–37 approximately £2,000.

*Provisions for publication of results:* For the present the Department issues no journal of its own. The results of researches are published in different journals already existing.

#### **Department of Oceanography of the University of Liverpool ('37)**

*History:* The Department was established by the University in 1919, when the late Sir W. A. Herdman endowed a professorship of Oceanography. The Liverpool Marine Biological Committee was then dissolved and its property transferred to the new Department. This property included the Port Erin Marine Biological Station. The Professors of Oceanography have been as follows: W. A. Herdman, 1919–1920; J. Johnstone, 1920–1932; J. Proudman, 1933 to present.

*Location:* The headquarters, laboratories, and museum are situated in Liverpool, 3.

*Organization to which attached:* The University of Liverpool.

*Purposes:* (i) To prosecute research. (ii) To train graduate-students in the methods of research. (iii) To serve as a bureau of information. (iv) To teach the elements of oceanography to undergraduate students.

*Scope of activities:* All branches of oceanography, physical and biological, including fisheries.

*Equipment:* Chemical and fisheries laboratories; museum of fisheries, relating principally to the Irish Sea; motor drifter with auxiliary sail.

*Staff:* Scientific, Prof. J. Proudman; Lecturer, R. J. Daniel; Technical and clerical.

*Provisions for visiting investigators:* Visiting investigators are subject to the general regulations of the University.

*Income:* General funds of the University. Amount: about £3,200 per annum, apart from the sum spent on the maintenance of the buildings.

*Provision for publication of results:* The Department administers a publications fund, which is expended in subsidizing the "Proceedings and Transactions of the Liverpool Biological Society."

#### **The Liverpool Observatory and Tidal Institute ('37)**

*History or origin:* The Institution was formed in 1929 by the union of the Liverpool Observatory and the Tidal Institute of the University of Liverpool. The Observatory was founded in 1845 and since 1858 has been maintained by the Mersey Docks and Harbour Board. The Tidal Institute was founded in 1919 with funds provided by Sir Alfred A. Booth, Bart., and Mr. Charles Booth.

*Location:* The Observatory is situated at Bidston on the Birkenhead side of the Mersey, but the Director and one assistant are normally stationed at the University in Liverpool.

*Organization to which attached:* The Institution is governed by a Committee appointed partly by the University of Liverpool and partly by the Mersey Docks and Harbour Board.

*Purposes and scope of activities:* The continuous prosecution of scientific research into all aspects of knowledge of the tides and of kindred geophysical subjects. The analysis of tidal observations and the preparation of tide-tables. The taking of meteorological and seismological observations, together with the supplying of information on

these subjects. The maintenance and firing of the Time-gun. The testing of chronometers and navigational instruments.

*Equipment:* Two tide predicting machines, one built for the Tidal Institute by Kelvin, Bottomley, and Baird; and one by Legé, built for the late Mr. Edward Roberts. A number of instruments for meteorological observation. Two Milne-Shaw seismographs, one sometimes used as an earth-tilt meter. A number of standard clocks, calculating machines, and wireless installations. Arrangements for testing sextants and chronometers.

*Staff:* Scientific: Director, J. Proudman; Associate Director, A. T. Doodson; Chief Assistant, H. J. Bigelstone; Assistant, R. H. Corkan. Technical and clerical: 6.

*Provisions for visiting investigators:* Special arrangements are made to suit each individual case.

*Income:* Source: Large grant from the Mersey Docks and Harbour Board.

Small grant from the University of Liverpool.

Interest on investments.

Earnings, amounting to about one-half of the total.

Amount: About £3,300 per annum, beyond the sum spent on the maintenance of buildings, rates, and taxes.

*Provision for publication of results:* The results of research are published in journals and societies' proceedings, references being given in the small Annual Report issued by the institution.

### The Hydrographic Department, Admiralty ('37)

*History or origin:* The Hydrographic Office of the Admiralty was established in 1795 in order to overcome the great inconvenience, especially when ordered abroad, felt by officers commanding His Majesty's Ships respecting the navigation, and to prevent the difficulty and danger to which His Majesty's Fleet must be exposed from defects on this head.

The first Hydrographer to be appointed was Mr. Alexander Dalrymple, F.R.S., who for many years was in the service of the East India Company; he was succeeded in 1808 by Captain Thomas Hurd, R.N., since which time the office of Hydrographer has been held by Naval Officers of captain's rank and above.

At its inception the cost of the Hydrographic Department was £470 per annum and the staff consisted of about four persons. At the present

day the estimates run into some £136,200 and the total number of persons employed by the Department is 330.

*Location:* Admiralty, Whitehall, London, with branches at Cornwall House, Waterloo Road, London, and at Cricklewood, London.

*Organization to which attached:* Admiralty.

*Purposes:* Hydrographic surveys, oceanography, compilation, engraving and printing of admiralty charts, sailing directions, light lists, tide tables, wireless time signals, notices to mariners, etc.

*Scope of activities:* British Empire, at home and abroad, and other work in the open seas which is of a world-wide nature.

*Equipment:* Eight surveying ships are employed—four abroad and four in home waters. The Department is fully equipped for all kinds of hydrographic and cartographic work. With the exception of two of the larger vessels, the whole of the surveying ships are being replaced by new construction and it is anticipated that an additional vessel will be available for service abroad making nine in all.

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
BEAUFORT.....	800	8	79
CHALLENGER.....	1,140	11	90
ENDEAVOR.....	1,280	11	129
FITZROY.....	800	8	79
FLINDERS.....	800	8	79
HERALD.....	1,650	11	121
IROQUOIS.....	1,760	10	121
KELLETT.....	800	8	79
ORMONDE.....	1,180	11	128

The names of the surveying vessels in the above list have been taken from the year book of the International Hydrographic Bureau for 1937.

The Royal Research ship RESEARCH is under construction at Dartmouth and when completed will undertake magnetic work at sea and the study of atmospheric electricity, oceanography, etc.

*Staff:* Hydrographer, Rear-Admiral J. A. Edgell, C.B., O.B.E.

Assistant Hydrographer, Captain E. F. B. Law, R.N.

Director of Navigation, Captain W. G. Benn, R.N.

Chief Civil Assistant, Mr. W. Ewart Llewellyn, O.B.E.

Superintendent of Charts, Commander A. Day, R.N.

Assistant Superintendent of Charts, Mr. G. B. Stigant.

Superintendent of Sailing Directions, Captain F. A. Reyne, R.N. (retired).

Superintendent of Tidal Work, Commander Harold D. Warburg, R.N. (retired).

Superintendent of Light Lists, Captain S. A. G. Hill, D.S.O., R.N. (retired).

Superintendent, Chart Production and Supplies Branch, Cricklewood, Mr. C. Jowsey.

*Provision for visiting investigators:* Naval officers, scientists, engineers, surveyors, and others, are, as a rule, shown over the Department provided arrangements are made beforehand.

*Income:* Derived from the sale of charts, etc., but is returned to the Treasury in accordance with the usual custom for Government offices.

*Provision for publication of results:* Charts are published by the Department and books by H. M. Stationery Office, as and when required.

#### **Meteorological Office (Marine Division) Air Ministry, London ('37)**

*History or origin:* The Meteorological Department of the Board of Trade was established in 1855 for marine meteorological work.

In 1865 the Meteorological Office was established as a separate department and the Meteorological Department of the Board of Trade became the Marine Division of the Meteorological Office.

In 1919 the Meteorological Office, with all its Divisions, was made a Department of the Air Ministry.

*Location:* Kingsway, London.

*Organization to which attached:* See above.

*Purposes:* To collect from British ships information on winds, weather, currents, and ice of the oceans with the object of improving ocean navigation and making it safer.

*Scope of activities:* The Marine Division arranges for and supervises the voluntary observations made by the officers of 350 British ships which make regular observations and of a number of ships which make occasional observations.

Of the 350 ships which make regular observations:

- (a) Thirty ships take observations at the end of each watch and record them in the Meteorological Log; these ships are engaged mainly in the North Sea, the north and south Pacific Ocean, and the Arctic and Antarctic.

- (b) The remaining 320 ships take observations at one or more of the international hours for synoptic observations at sea, namely 0000 hr., 0600 hr., 1200 hr., and 1800 hr. G.M.T. and record them on Form 911 which is called the Meteorological Record to distinguish it from the Meteorological Log referred to in (a) above.

- (c) Of the 350 ships referred to in (a) and (b) 281 are "Selected Ships" and transmit their observations at scheduled times by W/T for the information of other ships and of national meteorological services.

The meteorological logs and records from these ships are examined in the Marine Division and the necessary data extracted for discussion and publication. Special attention is being given at present to the data of ocean currents and a series of current charts of the oceans is being prepared and published.

In addition to the 350 regular observing ships arrangements are made with a number of British ships to make observations and to report them by W/T when they are in regions where there are no selected ships. The list of these ships is at present small but it is being added to as opportunity offers.

*Equipment:* All British Observing ships, whose names appear in the fleet list in the "Marine Observer," carry a reliable mercurial barometer.

The Meteorological Office lends to meteorological log-keeping ships a complete set of meteorological instruments, consisting of a Kew Pattern Marine Mercurial Barometer, Thermometers with screen, and Hydrometers.

"A" Selected Ships, that is Selected Ships which have long range wireless telegraphy, are also equipped with thermometers with screen and a barograph. Some "B" Selected Ships which have not satisfactory instruments of their own are also provided with thermometers and screens by the Office.

The Marine Division itself has the usual office equipment; has access to the technical and scientific library of the Meteorological Office, and has the advantage of the use of the Air Ministry Hollerith Electrical Sorting lithographic and printing presses.

*Staff:* Headquarters: Marine Superintendent, 1 nautical assistant, 1 meteorological assistant, 9 technical assistants, 13 clerical assistants. London Docks: 1 nautical assistant, 1 clerk.

Liverpool Docks: 1 nautical assistant, 1 clerk. Eight agents (master mariners resident at the ports).

*Provision for visiting investigators:* As occasion arises.

*Income:* Source: By Parliamentary vote.

*Provision for publication of results:* His Majesty's Stationery Office publish books, charts, and atlases, compiled in the Marine Division, as necessary.

#### **Fisheries Laboratory, Lowestoft ('37)**

*History or origin:* Staff of Marine Biological Association of the United Kingdom previously stationed at Lowestoft and engaged in International Investigations taken over by Ministry of Agriculture and Fisheries and transferred to London in 1910.

Present organization and location date from 1920, when the staff was greatly augmented.

*Location:* Lowestoft, Suffolk, England. On sea front between harbour and Claremont Pier.

*Organization to which attached:* Ministry of Agriculture and Fisheries, London.

*Purposes:* Study of fishery problems, both national and international, the latter in coöperation with the Conseil International pour l'Exploration de la Mer, Copenhagen.

*Scope of activities:* Problems connected with the life history of fishes and other forms of marine life, special attention being paid to those problems connected with over-fishing and the prediction of yield.

*Equipment:* 1 laboratory building, containing rooms for staff, library (about 5,000 volumes), lecture room and the usual equipment for research, 4 floors and basement, about 70 by 50 feet.

1 fisheries store—1 building three floors, 60 by 20 feet and 1 building 2 floors, 25 by 20 feet.

2 research vessels as follows:

GEORGE BLIGH, steam trawler of "Lord Mersey" type. Length 138½ feet; breadth 23¾ feet; depth 12¾ feet (in hold). Average draft aft 15 feet. Gross tonnage 324.27; register tonnage 131.53; H.P. Nominal 68.9; H.P. indicated 600.0. Cruising radius of about 5,000 miles.

ONAWAY, motor drifter, Scottish type. Length 53.2 feet; breadth 16.3 feet; depth 6.85 feet. Tonnage 26.73; engine: Norris, Henty, and Gardner, semi-diesel, B.H.P. 48, R.P.M. 450.

*Staff:* The Director of Fishery Investigations, Dr. E. S. Russell, is stationed in London.

*Resident staff:*

Mr. F. M. Davis (in charge), principal naturalist (biologist).

Mr. H. J. Buchanan-Wollaston, principal naturalist (biologist).

Mr. R. E. Savage, naturalist (biologist).

Dr. J. N. Carruthers, naturalist (hydrographer).

Mr. G. M. Graham, naturalist (biologist).

Dr. W. C. Hodgson, naturalist (biologist).

Mr. J. R. Lumby, assistant naturalist (hydrographer).

Miss D. E. Thursby-Pelham, assistant naturalist (biologist).

Commander W. H. Stewart, assistant naturalist (Master of the GEORGE BLIGH).

Mr. F. S. Wright, assistant naturalist (biologist).

Mr. H. H. Goodchild, assistant naturalist (biologist).

Mr. C. F. Hickling, assistant naturalist (biologist).

Mr. R. S. Wimpenny, assistant naturalist (biologist).

Mr. B. G. Clarke, chief laboratory assistant.

Mr. H. Stokes, 1st class laboratory assistant.

4 laboratory assistants.

Mr. E. A. Bennett, higher grade clerk (officer in charge).

Mr. W. H. Newsome, higher grade clerk (in charge of statistical and clerical staff).

11 clerical officers (Statistical Branch).

2 shorthand-typist.

3 fish-measurers.

*Provisions for visiting investigators:* Provision is made for visiting investigators by special arrangement.

*Income:* From State, for maintenance of station and ships approximately £9,000, for staff £15,480.

*Provision for publication of results:* The Ministry publishes the following series: "Fishery Investigations, Series II, Sea Fisheries." Provision is also made for occasional publication of Fishery Notices, which usually consist of pamphlets on special subjects for general public consumption.

#### **Plymouth Marine Laboratory ('37)**

*History or origin:* Established by the Marine Biological Association of the United Kingdom of which Professor Huxley was the first president and Sir Ray Lankester was the originator and first secretary. It was opened on June 30, 1888. The buildings and fittings had at that time cost £12,000. Between that time and 1933 a

sum exceeding £16,000 was spent on additional buildings. A general description of the buildings was published by Doctor E. J. Allen in *Marine Biological Association Journal*, vol. 15, no. 3, pp. 735-828, November, 1928. Subsequent to 1928 the buildings were enlarged by the addition of several rooms. On the ground floor, a library room, two work rooms, photographic room, and a physiological laboratory were added. On the first floor a balance room, two small laboratories, and a large chemical laboratory were added. The description published by Dr. Allen needs to be supplemented by the additional buildings mentioned in the foregoing sentences.

*Location:* Plymouth on the sea front of Citadel Hill.

*Organization to which attached:* The Marine Biological Association of the United Kingdom.

*Purposes:* All kinds of biological research, with special attention to several fisheries problems, the study of hydrographic conditions in the adjacent waters of the English Channel, the provision of facilities for visiting investigators, and the conduct of Easter and Autumn classes for students.

*Scope of activities:* Since the Marine Biological Laboratory in Plymouth has been in continuous operation since 1888, it would reasonably be expected that there might be some change in the program and the emphasis which has been placed on different kinds of problems during the forty-five years of the existence of the Laboratory. The scope of the investigations at the Institution is indicated by the designations after the names of the members of the staff as given below. A wide variety of the problems of the physiology of marine organisms and the interrelation between the organisms and the marine environment are being investigated. Several of the investigators are concerned with the life histories of marine organisms, others are studying special fisheries problems. The Laboratory also pays particular attention to hydrography and to the chemistry of sea-water as related to marine organisms and other phenomena. It supplies specimens of marine animals and plants for biological research and teaching purposes.

*Equipment:* The original building contained a general laboratory with cubicles and a series of small aquaria for the use of the staff or visiting investigators; and the aquarium on the ground floor which is opened to the public; an extensive library of biological publications which includes

the leading biological and biochemical journals; a residence for the director; four or five small laboratories; and an office and living quarters for the engineer-caretaker. Subsequently an additional building known as the Allen building, 24 feet by 24 feet in dimension, divided into two laboratories by a temporary partition was added. Later a second story was added to this building and the whole was converted into a library. At a still later date there was added a new wing in which there is a well-equipped chemical laboratory and a large and varied stock of chemicals, and well-equipped physiological and fisheries laboratories. On the ground floor there is an aquarium or tank room which measures 70 feet by 24½ feet. There is a detached building for the vacation courses with accommodation for twenty students. The Laboratory owns a wooden steam drifter, the SALPA, which is 88 feet long, 19.9 foot beam and draws 10.5 feet aft and 5 feet forward, and is capable of a speed of 9½ knots. She is equipped with a winch for trawling and a small deck-house laboratory. The Laboratory also owns the motor boat GAMMARUS which is 25 feet long, eight-foot beam, a draught of 2 feet 9 inches.

The library contains a valuable collection of scientific books, periodicals, and reports of all countries relating to fish and fisheries, the collection in this respect being one of the most complete in the country. The more important zoological journals are well represented, as well as the reports of the various oceanographical expeditions, and there are a large number of separate papers on general marine biology. A collection of modern books and journals dealing with general physiology has also been added. Members of the Association have access to the library.

*Staff:* Director, Stanley Kemp, Sc.D., F.R.S.

Assistant Director and Fishery Naturalist, E. Ford, A.R.C.Sc.

Head of Department, General Physiology, W. R. G. Atkins, O.B.E., Sc.D., F.I.C., F.Inst.P., F.R.S.

Naturalist, Miss M. V. Lebour, D.Sc., Plankton and larval stages of bottom fauna.

Hydrographer, H. W. Harvey, M.A.

Naturalist, F. S. Russell, D.S.C., D.F.C., B.A., Plankton and young fishes.

Physiologist, A. Sand, Ph.D.

Naturalist, D. P. Wilson, M.Sc., Polychaete larvae and shore fauna.

Director's research assistant. Mrs. E. W. Sexton, F.L.S., Mendelian heredity.

Assistant Naturalists: G. A. Steven, B.Sc., F.R.S.E., fishes and the commercial fisheries.

G. M. Spooner, M.A., Behavior of fishes.

Assistant Chemist, L. H. N. Cooper, Ph.D., F.I.C.

Research Assistants: W. J. Rees, M.Sc., Hydroids and medusae; P. G. Corbin, Mackerel.

*Provision for investigators:* The accommodation provided for visitors includes cubicles, separate rooms, or bench space with adequate fittings for biochemical and physiological work, the use of all ordinary glassware, chemicals, and apparatus of a general nature. The Association undertakes, as far as possible, to supply the animals or plants or water samples required for any investigator, or such facilities for obtaining them as may be at the command of the Laboratory.

Microscopes are not usually provided. Intending visitors are advised to write to the Director, stating the nature of the investigation which they propose to carry out and the apparatus which they will require. Every effort is made to provide any special apparatus which is needed, and to collect the animals wanted for research.

The Laboratory is open for research during the entire year, including holidays, and workers are provided with a key so that they may work at night when they desire to do so.

The facilities are primarily intended for visitors who are engaged in their own research or wish to collaborate with members of the staff who are investigating some particular problem of biological science.

About thirty investigators can be accommodated in addition to the regular staff of the Laboratory.

*Income:* Source. A grant from the Government, private donations, the dues of the members of the Marine Biological Association, entrance fees to the aquarium, and sales of specimens.

Amount. About £16,000 annually.

*Provision for publication of results:* The Journal of the Marine Biological Association of the United Kingdom and various scientific periodicals. "The Plymouth Marine Fauna", published by the Association in 1931 contains a list of the local species and notes on their distribution.

#### Port Erin Marine Biological Station ('37)

*History or origin:* The Liverpool Biological Committee was founded at a Public Meeting in 1885

which was called by Sir William Herdman and held in the Zoological Laboratory at University College, Liverpool. It was resolved to investigate the Marine Biology of Liverpool Bay.

1892 Original Station at Port Erin erected.

1902 Present Station at Port Erin erected with coöperation of Isle of Man Government.

1910 A new wing added to main building.

1932 New laboratory added to main building.

*Location:* On the south side of Port Erin Bay, southwest coast of Isle of Man, situated in Irish Sea.

*Organization to which attached:* The Liverpool Marine Biological Committee in December, 1919, transferred the Station to the University of Liverpool (Department of Oceanography).

*Purposes:* Main building in three parts. An aquarium for the public, a sea fish hatchery, and a biological station proper. The latter provides laboratories and working accommodation for students. These classes attend with members of the staff of their own particular university. No instruction at present carried on by resident staff which is engaged in research.

*Scope of activities:* Fishery research in connection with the Manx Herring Fisheries. Investigations upon the rearing of oyster larvae (*Ostrea edulis*).

*Equipment:* Main building, 90 feet by 40 feet, 2 stories. Details as follows:

Center block, aquarium 30 feet by 30 feet, with gallery. 9 main tanks and subsidiary ones.

Wing, fish hatchery, 30 feet by 26 feet. Ground floor: Nine fleets of hatching boxes. First floor: Biochemical laboratory.

Wing, biological, 30 feet by 26 feet. Ground floor: Six separate research rooms and library. First floor: Combined laboratory and lecture room.

To the foregoing there have been added, as follows:

New wing 1910: 44 feet by 18 feet, 2 stories. Ground floor: Store room, dark room, 2 class rooms for 8-10 students, and room containing sorting tables (for sorting collected material). First floor: 8 separate research rooms.

New laboratory 1932, single story and built to take a second story if necessary. Accommodation for 25 students.

Tanks, two outside tanks for storing sea water and used as spawning ponds in connection with hatchery. Capacity of each about 16,000 gallons.

An upper tank built into the cliff face. Capacity 11,000 gallons.

*Staff:* Honorary Director, R. J. Daniel, D.Sc., Lecturer in Oceanography, University of Liverpool.

Naturalist and Biochemist, J. R. Bruce, M.Sc.

Algologist, M. W. Parke, Ph.D.

Curator, Mr. W. C. Smith.

Assistant Curator, Mr. T. N. Cregeen.

Fisherman Naturalist, Mr. W. Christian.

Assistant, Mr. K. Woodworth.

*Provisions for visiting investigators:* During Easter vacation because so many students use the station, no visitors can be accommodated, but for the rest of the year it can house nine investigators with a cubicle each. If more than nine are accommodated, cubicles have to be shared or work done in the big laboratories.

*Income:* Sources: University of Liverpool; Isle of Man Government; British Government (Development Commission); Aquarium receipts.

Amount: About £2,450 per annum.

*Provision for publication of results:* The Annual Report of station includes Faunistic and Algal Notes. The staff publish in recognized British Journals. Fishery work is published in *Proceeding and Transactions of Liverpool Biological Society*.

#### ESTONIA

##### Kaitsevägede Staabi Topo-Hüdrograafia Osakond (Topographical and Hydrographic Section of the General Staff of the Army) ('37)

*Location:* Toomkooli, 9, Tallinn.

*Staff:* Head of the Section, Kolonel-Leitnant Eduard Ahman; Head of the Hydrographic Sub-Section, Vanemleitnant J. Weizenberg.

#### FINLAND

##### The Bureau for Fishery Investigations ('37)

*History or origin:* Founded in 1924.

*Location:* Helsinki.

*Organization to which attached:* Board of Agriculture.

*Purposes and scope of activities:* To carry out investigations relating to economics of fisheries, both in the sea and in lakes. Until now principally salmon and coregonid fishing has been studied.

*Staff:* Two scientific workers: Chief: Prof. T. H. Järvi. Biologist, Vidjo Jääskeläinen.

*Provisions for visiting investigators:* None.

*Income:* In the budget of the Government.

*Provision for publication of results:* Suomen Kalatalous, Finlands fiskerier, Acta Zoologica fennica, and Annales Acad. sc. fennicae.

##### Laboratory for Hydro-biological Investigations ('37)

*History or origin:* Established in 1919. (Earlier organization from 1899.)

*Location:* Helsinki (Helsingfors).

*Organization to which attached:* Finnish Society of Sciences.

*Purposes and scope of activities:* The study of the lower plant and animal life of the sea and inland waters of Finland.

*Equipment:* Laboratory for microscopical works.

*Staff:* 1 permanent worker, two others who take part in the work. Director: Prof. K. M. Levander. Assistant Zoologist: Mag. phil. Sven Segerstrale. Assistant Botanist: Dr. Ernst Häyrén.

*Provisions for visiting investigators:* No regular.

Item in the budget of the Finnish Society of Sciences.

*Provision for publication of results:* In the series *Commentationes biologicae Societatis Scientiarum Fennicae*.

##### Merenkulkuhallitus Merikarttalaitos (Board of Navigation, Hydrographic Office) ('37)

*Location:* Helsinki.

*Staff:* Director General of Board of Navigation, Captain I. A. Jokinen.

Head of Hydrographic Office, Kapteeniluutnantti U. Suomela.

Assistants, Captains L. Parrio and G. Kolckmann.

Head of Chart Section, Kapteeni L. Parrio.

Head of Section for Notices to Mariners, Kapteeni G. Kolckmann.

Heads of Surveying and Sweeping Expeditions, Captains J. Hyrsky, E. Elo, and A. Hakri, Kapteeniluutnantti T. Fabritius, Merivaenluutnantti E. Kerttula.

*Equipment:*

SURVEYING VESSELS	DISPLACE- MENT	OFFICERS	CREW
SEXTANT.....	195	9	31
YSTAVA.....		3	17
ALAND.....	65	1	
KLAS HORN.....	420	10	31
NAUTILUS.....	140	9	15
KAIKU 1	} Echo sound- ing launches		
" 2			
" 3			
" 4			

**Thalassological Institute, Finland<sup>1</sup> ('37)**

*History or origin:* Established in 1918. (Earlier organization from 1899.)

*Location:* Helsinki (Helsingfors).

*Organization to which attached:* Governmental Scientific Institution and the Ministry of Commerce.

*Purposes and scope of activities:* Scientific studies around Finland: general conditions, the physical and chemical properties of the sea water, the variations of the water level, the currents and the ice, as well as other related questions. Regular ice reports for navigational purposes issued during winter. The Institute represents Finland in international oceanographic work.

*Equipment:* Laboratory for work on the physical and chemical aspects of oceanography; wireless station; 17 water-stage registering stations, 21 tide-pole stations; more than 100 stations for ice-observation; routine oceanographic observations made at 26 coastal stations and 8 light vessels; s.s. NATULIUS placed at the disposal of the institution for the work in summer.

*Staff:* Scientific:

Director: vacant. Acting Director: Mag. G. Granqvist.

Consulting members: Prof. Hj. Tallqvist; Prof. K. M. Levander.

Thalassologists: Dr. S. E. Stenij, Chief of Section for the study of Water-Level; Dr. E. Palmén, Chief of Thalassological Section; Mag. G. Granqvist, Chief of Section for Ice.

Scientific assistants: Mag. Risto Jurva; Dr. Stina Gripenberg; Two vacant.

Technical and clerical: 5; 1 wireless operator.

*Provisions for visiting investigators:* No regular.

*Income:* Item in the budget of the Government.

*Provision for the publication of results:* Finländische Hydrographisch - Biologische Untersuchungen, quarto, nos. 1-10, and 12 and 13 published between 1907 and 1914. No. 11 has not been published (not continued).

Present series of publications: Merentutkimuslaitoksen Julkaisu (Finnish), Havs forskningsinstitutets Skrift (Swedish), octavo, nos. 1-108

<sup>1</sup> Witting, Rolf, Organization des Instituts für Meeresforschung in Finnland, III Hydrologische Konferenz der Baltischen Staaten, Warszawa, Mai 1930.

Witting, Rolf, and Granqvist, Gunnar, Thalassological work in Finland. Appendix 9, pp. 52-58; Association d'Océanographie Physique, Vème, Assemblée Générale réunie à Lisbonne 1933, Procès-Verbaux No. 1, Appendix 9, pp. 52-58, Helsingfors 1934.

Annual Reports for the years 1919-1935, published in the series mentioned below.

published between 1920 and 1936. The publications are issued either in Finnish and Swedish (separately or bilingual) or in English, German, or French.

## FRANCE

**Le Laboratoire Arago de Banyuls sur Mer ('37)**

*History or origin:* Established in 1881 by Henri de Lacaze-Duthiers.

*Location:* Banyuls sur Mer.

*Organization to which attached:* Part of the Faculté des Sciences de Paris. (As also Lab. de Roscoff.)

*Purposes:* Zoology and botany.

*Scope of activities:* Marine biological and oceanographic conferences and practical work for the students of the University.

*Equipment:* 22 individual work-rooms, more than 40 work places in common rooms; 28 sleeping rooms, 5 of them double. Public aquarium, besides an aquarium set aside with work benches. 1 gasoline boat St. VINCENT; 3 small boats (canot); Important library.

*Staff:* Director, Professor O. Duboscq; Chef de travaux, Mlle. O. Tuset; Assistant, M. LeCalves; 1 chief mechanic, M. Becque; 1 assistant; 1 chauffeur; 4 sailors; 1 laboratory assistant.

*Provisions for visiting investigators:* The prices of the work places is fixed at 200 francs per month. There is no charge to investigators from those countries who have rented a table by the year (4,000 francs).

*Income:* Source: Work tables and the sale of animals, 10,000 francs; budget from the University, 150,000 francs; Amount, 160,000 francs.

*Provisions for publication of results:* Generally in the Archives de Zoologie Expérimentale.

**Station Biologique d'Arcachon ('34)**

*History or origin:* Established in 1863.

*Location:* Arcachon (Gironde).

*Organization to which attached:* Private, belonging to La Société scientifique d'Arcachon.

*Purposes:* Marine biology.

*Equipment:* 10 laboratories, 1 for physiological studies, all possessing fresh and sea water, gas and electricity. Motor boat; important library; rooms for workers.

*Staff:* Scientific:

Director, Dr. R. Sigalas, Professor of Faculty of Medicine, Bordeaux.

Librarian-keeper of collections, Com. Metzger.

**Maintenance and operation:**

2 sailors, in charge of fisheries and laboratories.

1 porter.

*Provisions for visiting investigators:* On request to the director, he puts at the disposal of workers its laboratories, material, and library. Furnishes animals and plants at cost to French and foreign laboratories. Boat at disposal. Finds accommodations for workers on larger fisheries boats. Rooms at disposal of visitors for a small sum for service.

*Income:* From La Société scientifique d'Arcachon.

*Provision for publication of results:* Bulletin of Station Biologique d'Arcachon.

**Laboratoire de Luc-sur-Mer de la Faculté des Sciences de Caen ('37)**

*History or origin:* Established 1880.

*Location:* Luc-sur-Mer (Calvados).

*Organization to which attached:* Small university of Caen. State Institution.

*Equipment:* Working library, fishing boat, aquaria for marine animals.

*Staff:* Director, M. Mercier, Professor, faculty; Sub-Director, M. Audigé, Professor, faculty; Chief of Laboratory, Me. Le Roux; Assistant, M. Guibé.

*Provisions for visiting investigators:* Rooms at the disposition of workers.

**Laboratoire de Zoologie et de Physiologie Maritimes du Collège de France ('37)**

*History or origin:* Established in 1859 by Coste.

*Location:* Concarneau (Finistère). On the sea-front, between the pier and the fish market. Annex on the Cigogne (archipel des Glénans).

*Organization to which attached:* Collège de France. State institution.

*Purposes:* Orientation: questions of pure and applied marine biology.

*Scope of activities:* Marine zoology and physiology, chemistry.

*Equipment:* Laboratory building, 3 floors, 33 x 9 meters. Rooms and apparatus for chemistry, physiology, histology, fishing. Aquarium of sea water and sea-tanks. Collecting apparatus (appareils d'élevage). Motor-, sail-, row-boats. Library and collections.

*Staff:* M. Faral, administrator of the Collège de France. MM. Duclaux, Fauré-Fremiet, Jolly, Mayer, Nageotte, Nattan-Larrier, Piéron (Professors at Collège de France). Sub-Director, R.

Legendre. Preparator, H. Bouxin. 2 operation workers.

*Provisions for visiting investigators:* Between 20 and 25.

*Income:* Source: State.

Amount: About 80,000 francs.

*Provision for publication of results:* Travaux du Laboratoire (suspended since the war).

**Laboratoire Maritime (Aquarium et Musée de la Mer) du Muséum national d'Histoire naturelle ('37)**

*History or origin:* Established in 1924 at Saint Servan, transferred in 1935 to a new locality at Dinard opposite the preceding on the left bank of the Rance.

*Location:* Situated at Dinard (Ille et Vilaine), 17 Grande Rue, at the mouth of the Rance.

*Organization to which attached:* The Museum of Natural History, Paris.

*Purposes:* Researches in oceanography and marine zoology; zoology, botany (algae), geology, physiology, etc.

*Scope of activities:* All marine biological sciences and fresh water in general.

*Equipment:* Four rooms for one or two workers; one room for five workers; one laboratory for physiological chemistry for three workers; one large room for four workers: In all seven rooms with a library of current literature. One large library containing periodicals and various treatises, about 3,000 volumes. One sail boat with a motor twenty-six tons, 24 hp. motor; one "scout" and one "you-you," each with a 10 hp. motor, and small boats.

*Staff:* Director, M. A. Gruvel, Professor at the Museum; Sub-Director, M. H. Bertrand, D.Sc.; Four employees and boatmen.

*Provisions for visiting investigators:* The workers are lodged in a beautiful villa adjacent to the laboratory and situated in a large garden. The villa contains 15 rooms, each for one or two persons.

*Income:* Derived from the entrance fees to the aquarium and a subvention from the government.

*Provision for the publication of results:* Bulletin du Laboratoire maritime de Dinard which appears irregularly in fascicules contains résumés of the results of persons who work at the laboratory.

**Laboratoire de Guethary ('34)**

*History or origin:* Established in 1893.

*Location:* Guethary (Basses-Pyrénées).

*Organization to which attached:* Annexed to the Station Biologique d'Arcachon. Private institute. Personal laboratory of M. C. Sauvageau, Professor on the Faculty of Sciences at Bordeaux.

*Purposes:* Marine biology.

*Scope of activities:* Fauna and flora, algology.

*Staff:* Director, M. C. Sauvageau, Honorary professor of the Faculty of Sciences at Bordeaux.

*Provisions for visiting investigators:* At the disposition of workers who apply to the Director of the Station Biologique d'Arcachon.

*Income:* From the Société scientifique d'Arcachon.

*Provision for publication of results:* Bulletin de la Station Biologique d'Arcachon.

#### **Institut Océanographique du Havre ('27, Magrini)**

*History or origin:* Established 1918 and endowed by a budget from the Municipality of Havre; is aided morally and financially by the Société des Amis de l'Institut Océanographique du Havre.

*Location:* Havre.

*Organization to which attached:*

*Scope of activities:* Laboratory of marine biology, aquarium of fresh water (Muséum du Havre); observations on board the steamers of Ponts et Chaussées (towing, fueling) and fishing barks.

*Equipment:* Laboratory, work-shop.

*Staff:* Director, Dr. Adrien Loir; Laboratory chief: M. Henri Legangneux, pharmacist; Chief, biological works: M. Étienne Peau.

*Provision for publication of results:* In Bulletin de la Société des Amis de l'Institut Océanographique du Havre.

#### **Laboratoire de Biologie Marine de "Le Croisic" ('34)**

*History or origin:* Established in 1920, reattached in 1922 to the School of the Practice of Medicine and Pharmacy at Nantes (École de plein Exercice de Médecine et de Pharmacie de Nantes).

*Location:* Le Croisic on the Loire Inférieure, France.

*Organization to which attached:* École de plein Exercice de Médecine et de Pharmacie de Nantes.

*Purposes:* Marine biology, oceanography, oyster-culture, fauna and flora of salt marshes. Open in July, August, September.

*Equipment:* Working library; 1 laboratory building, 1 floor; 1 research boat CYROS; several service buildings.

*Staff:* Director, Prof. Alphonse Labbé, École de médecine de Nantes.

*Provisions for visiting investigators:* Seven or eight can be accommodated.

*Income:* Source: Municipalité de Nantes.

Amount: 500 francs annually.

#### **Laboratoire Marion de Marseille (Endoume) ('37)**

*History or origin:* Created by F. Marion in 1834.

*Location:* On the sea shore at Marseille (Endoume), France.

*Organization to which attached:* Faculty of Sciences of Marseille.

*Purposes and scope of activities:* Instruction and research in marine zoology.

*Equipment:* Aquarium; 4 research laboratories; laboratory of physiological zoology; the library is that of the Faculty of Sciences at Marseille.

*Staff:* Director, M. Kollmann, professor in the Faculty of Sciences; chief in charge, M. M. Van Gaver; in charge of work, Timon David.

*Provisions for visiting investigators:* Nine or ten workers can be accommodated.

*Income:* Source: Budget of the Faculty of Sciences and the Chair of Zoology.

Amount: About 20,000 francs.

*Provision for the publication of results:* In Travaux du Laboratoire de Zoologie et du Laboratoire Marion (Extraits des Annales de la Faculté des Sciences de Marseille); et Annales du Musée de Marseille.

#### **Institut Océanographique ('37)**

*History or origin:* Created and endowed in 1906 by S. A. S. Albert the First, Prince of Monaco, and recognized by the French Government as a public utility on May 16, 1906.

*Location:* 195 Rue St. Jacques, Paris.

*Organization to which attached:* Independent institution.

*Purposes:* The institution is for research and advanced and popular instruction in oceanography.

*Scope of activities:* All kinds of oceanographic researches and the physiology of marine animals. The work at sea is conducted in the coastal laboratories (laboratories of the Oceanographic Museum of Monaco and laboratories of National Education).

*Equipment:* Laboratories of three services especially equipped for researches in oceanography and physiology. Special library of oceanography to which is attached the library of the Zoological Society of France.

*Staff:* Assistant Secretary, M. Richet.

Professors: L. Fage, biological oceanography, Francis Bernard, assistant. Physical oceanography, this year replaced by conferences

conducted by various scientists. Paul Portier, physiology of marine organisms, M. Fontaine, assistant.

*Provisions for visiting investigators:* The laboratories are open to French and foreign investigators accepted by the professors.

*Income:* Endowment made in 1922 by S. A. S. Albert Ier, Prince de Monaco, and the receipts from the Musée Océanographique de Monaco.

*Provision for publication of results:* Annales de l'Institut Océanographique which constitute annually a volume of about 400 quarto pages.

#### Office Scientifique et Technique des Pêches Maritimes ('37)

*History or origin:* By law of December 31, 1918.

*Location:* 3, Avenue Octave Gréard, Paris.

*Organization to which attached:* Ministère de la Marine Marchande.

*Purposes:* Scientific and technical researches concerning marine fisheries.

*Scope of activities:* Chemical and biological researches concerning fish. Technical research concerning fishing gear, nets, oils, preservation, sanitary control of oyster culture, and studies on the wholesomeness of shell-fish.

*Equipment:* Laboratories (See attached note) and research vessel. Scientific laboratory at the office in Paris. Chemical laboratory at the office in Paris. Technological and Low Temperature Laboratory in Paris. Laboratory of Ostrea culture in Paris. Biological laboratory at Boulogne-sur-Mer. Biological Laboratory at Lorient. Biological Laboratory at La Rochelle. Biological Laboratory at Biarritz. Laboratory of Sanitary Control at Auray. Laboratory of Sanitary Control at St. Servan. Laboratory of Sanitary Control at La Rochelle. Laboratory of Sanitary Control at La Tremblade. Laboratory of Sanitary Control at Arcachon.

*Staff:* Director, M. Edouard le Danois, Dr. Sc.

Administrative Personnel: Administrative Secretary, M. D. Remy, Lic. es. 1, 8 collaborators. Scientific Personnel: 5 chiefs of laboratories; 6 preparators.

Personnel of Sanitary Control: Inspector general, M. L. Lambert, Dr. Pha.; 7 regional inspectors; 4 laboratory assistants; 10 attendants; 1 employee.

In command of the research vessel: M. L. Beaugé, Capitaine de Frégate de Réserve, Commandant, le navire dont le port d'attache est à Lorient.

*Provisions for visiting investigators:* Foreign scientists can be received in the different laboratories after an understanding with the director of each establishment.

*Income:* Amount: The total annual budget of the office is about 3,000,000 Frs.

Source: Derived from taxes levied on the fishing vessels, owners of fishing establishments, fish packers. To these are added the products of sales of the publications of Sanitary Control.

*Provision for the publication of results:* Notes and Mémoires and Revue des Travaux. The Memoirs of which a list is on the backs of the new volumes published since 1928 from la Revue des Travaux de l'Office des Pêches Maritimes.

The personnel of the different laboratories is as follows:

Laboratoire de Boulogne-sur-Mer—17, Boulevard de Chatillon: M. Le Gall, Agrégé d'Université, Chief of the Laboratory; M. Furnestin, Preparator; 1 laboratory boy; 1 laboratory aide.

Laboratoire de Lorient—Port de Pêche de Lorient Kéroman: M. Desbrosses, Lic. es sc., Chief of the Laboratory; M. Priol, Preparator; 1 laboratory boy; 1 woman servant.

Laboratoire de La Rochelle—74, Allées du Mail: M. Belloc, Lic. es sc., Chief of the Laboratory; M. Cadenat, Lec. es. sc., Preparator; 1 laboratory boy; 1 housekeeper.

Laboratoire de Biarritz—Palais de la Mer à Biarritz: M. Arné, Lic. es. sc.; M. X. . . . Preparator.

Laboratoires de Chimie—d'essais technique et frigorifiques—et de biologie ostréicole, 3, Avenue Octave Gréard à Paris: M. Boury, Agricultural Engineer, Chief of the Chemistry Laboratory; M. Bonfils, Preparator, in charge of low temperature studies; M. L. Borde, Preparator, in charge of oyster culture.

Sanitary Control: Inspector General, M. Lambert, Dr. Pha., 1 employee. Regional Inspector of Le Havre: M. Chevallier. Regional Inspector of St. Servan: M. Jardin, M. —, Laboratory Assistant. Regional Inspector of Brest: M. Lesquin. Regional Inspector of d'Auray: M. Herman; M. Mercier, Laboratory Assistant; M. le Goff, Assistant; M. Ligeour, Assistant; M. Vaugrenard, Assistant. Regional Inspector of La Rochelle: M. Dupain; M. Chemin, Laboratory Assistant; M. Adrien, Assistant. Regional Inspector of La Tremblade-Marennes: M. Chaux-Thevenin, Lic. es sc.; M. Baron, Preparator Aide; Mme. Baron, Laboratory Assistant; Mm. Bordin, Charles, Evêque, Fayard, Le Baron, Assistants. Regional Inspector of d'Arcachon: M. Ladouce, Dr. Pha.; Mme. Lanau, Laboratory aide; M. Raby, Assistant; M. Deyzi, Assistant; M. Clemenceau, Assistant.

**The boat *Pourquoi-Pas* (Laboratory of marine research of l'Ecole Pratiques des Hautes Études**

attached to the Muséum national d'Histoire naturelle)

This vessel and M. Charcot were lost on the west coast of Iceland on September 16, 1936, but subsequent publications may contain accounts of scientific results.

*History or origin:* Established in 1911.

*Location:* Usually at St. Servan (Ille-et Villaine), but may change ports.

*Organization to which attached:* State.

*Purposes:* Any scientific investigations in connection with the sea.

*Scope of activities:* All regions including polar.

*Equipment:* The POURQUOI-PAS was a 3-mast boat, 500 tons, steam engine of 500 hp. Sounding, dredging apparatus, etc. Laboratories, and could accommodate a major scientific establishment of 4 to 7 persons. Cruises were available from the military Marine for three months of the year.

Library: 1,000 volumes, physical, biological oceanography; general science; literature.

*Staff:* Director, Dr. J. B. Charcot; Technical and clerical (variable): Generally 4 to 7.

*Provisions for visiting investigators:*

*Income:* Source: State, Military Marine and Instruction Department combined.

Amount: About 100,000 francs a year. Depended on cruises and necessary repairs.

*Provision for publication of results:* Rapport annuel dans le *Bulletin du Service hydrographique*.

#### **Service Central Hydrographique (de la Marine) ('37)**

*History or origin:* Founded in 1817.

*Location:* 13 Rue de l'Université, Paris.

*Organization to which attached:* Ministry of the Military Marine.

*Purposes:* Setting up and publication of marine charts, nautical works, tide tables for navigators; instruction for (a) young hydrographic engineers and foreign officers, (b) for marine officers candidates for deputy hydrographers.

*Scope of activities:* Improvement of marine charts and nautical works; study of coastal processes in collaboration with the Department of Public Works; improvement of chronometers, sextants, sounding instruments, etc.; perfection of meteorological observations on board ships. Incidentally, support of oceanographic studies.

*Equipment:* 1 building, Service Hydrographique à Paris, 85 m x 25 m, offices, studios for design, engraving, photography printing.

Library, 60,000 volumes, store-room.

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
YPRES.....	654	7	104
LA PEROUSE.....	793	10	105
UTILE.....	323	4	67
GASTON RIVIER.....	320	2	55
ESTAFETTE.....	320	3	31
SENTINELLE.....	320	3	31
OCTANT.....	320	3	31
ASTROLABE.....	320	3	31
DUBOURDIEU.....	460	2	64
CRABE.....	370		17
TOURTEAU.....	360		17
SEMINOLE.....	800	2	51
CAP-VERD.....	333		30

*Staff:* Hydrographer, Ingénieur Hydrographe Général Cot.

Assistant Hydrographer, Ingénieur Hydrographe en Chef de 1<sup>re</sup> Classe Courtier.

Head of 1st Section (General Hydrography), Ingénieur Hydrographe en Chef de 2<sup>me</sup> Class Péliissier.

Head of 2nd Section (Coasts of France), Ingénieur Hydrographe en Chef de 1<sup>re</sup> Classe Volmat.

Head of 3rd Section (Charts and Archives), Ingénieur Hydrographe en Chef de 1<sup>re</sup> Classe Ricard.

Head of 4th Section (Sailing Directions), Capitaine de Frégate Saillant.

Head of 5th Section (Scientific Instruments), Ingénieur Hydrographe en Chef de 2<sup>e</sup> Classe Villain.

Head of 6th Section (Tides), Ingénieur Hydrographe en Chef de 2<sup>e</sup> Classe Villain.

Head of 7th Section (Maritime Meteorology), Capitaine de Vaisseau Ladonne.

1 technical counsellor for oceanography.

20 engineers, officers in Paris.

20 officers on board ship.

20 deputy hydrographers.

*Provisions for visiting investigators:* Up to the present the Service has entertained only 3 engineers or foreign officers per year.

*Income:* Budget for 1932, 7,000,000 francs; 1933, 5,600,000 francs.

*Provision for publication of results:* Annales hydrographiques; Recherches hydrographiques sur le Régime des Côtes; Annuaire des Marées des Côtes de France; Tables des Marées des Colonies françaises de l'Atlantique, de l'Océan Indien, des mers de Chine.

### Station Biologique de Roscoff (Laboratoire Lacaze Duthiers) ('37)

*History or origin:* Established in 1871 by H. Lacaze-Duthiers and enlarged by his successor Yves Delage in 1909. More recently, in 1930, new additions to grounds and real estate have doubled the area of the station which is now about 60 ares.

*Location:* Roscoff (Finistère).

*Organization to which attached:* Attached administratively to the Faculty of Sciences of the University of Paris. With the Laboratoire Arago de Banyuls sur Mer it constitutes the National Institute of Marine Biology of the University of Paris. Each of these laboratories is autonomous and has its own director and its own budget.

*Purposes:* All researches relative to marine biology in the most general sense; also instruction of students.

*Scope of activities:* Laboratories fitted for researches in zoology, parasitology, botany, algology, histology, embryology, physiology, bacteriology, physics, and biological chemistry; also laboratories for instruction.

*Equipment:* 25 large stalls for investigators; 10 small stalls for beginners in research; laboratory of physiology; stalls for physics and chemistry; dark-rooms for photography; sea water, fresh water, gas, and electric current everywhere; vacuum in the rooms for physiology, physics, and chemistry; aquarium room with 2 large basins and 47 stalls assigned to investigators; library, 2,000 volumes, 5,000 brochures and reprints, 70 periodicals, altogether about 10,000 volumes; lodging, 40 rooms in which 50 people can be accommodated. Boats: DUNDEE with a motor, 18 tons, 10.5 m long, power 30 c.v.; gasoline boat, 4 m; small boats. Automobile, 1 omnibus, 14 c.v., 17 seats and 1 conveyance, 16 c.v., 7 seats, with an effective range of 100 kil. around Roscoff; blacksmith shop, mechanical shop, locksmith shop, carpenter shop.

*Staff:* Director, Charles Pérez, Professor of Zoology at the Faculty of Sciences of Paris, Member of the Academy of Sciences. Sub-director, Georges Teissier, Chief of Investigations at the Faculty of Sciences of Paris. Assistant, Marcel Hérubel. Assistant preparator, Pierre Manigault. Sub-ordinate personnel: 5 marines (seamen, fishermen); 1 porter.

*Provisions for visiting investigators:* Tables may be rented by governments, academies, universities, or other official foreign organizations or institu-

tions. Requests should be addressed to the Director, M. Charles Pérez, 1, Rue Victor Cousin, Paris 5.

*Income:* Sources: Budget from the Faculty of Sciences of the University of Paris, rent for tables, special donations.

Amount: About 250,000 francs per annum.

*Provision for publication of results:* Travaux de la Station Biologique de Roscoff; Memoirs or monographs published singly, since 1923. "Les Presses Universitaires de France," Paris. The investigators are free to publish their results in periodicals of their own choosing.

### Station Biologique de Sète ('34)

*History or origin:* Established in 1896. Founded by the University of Montpellier by means of state and regional contributions.

*Location:* Sète, Hérault (the spelling "Sète" is the new official spelling for Cette).

*Organization to which attached:* The Institute of Zoology and of General Biology of the University of Montpellier and École pratique des Hautes Études, Paris.

*Purposes:* Biological investigations, as stated below.

*Scope of activities:* The biological study of the fauna and flora of the shore, the sea, the salt lakes, the salt marshes, and the fresh waters of Bas-Languedoc; experimental researches; the site of the Laboratory of the Biology of the Protista of the École des Hautes Études, Paris.

*Equipment:* 2 buildings. Of these the principal one contains research laboratories, 10 rooms, of which 8 are individual and 2 for groups; 1 room for practical instruction; 1 room for collections; a library; 2 rooms for a public aquarium; local quarters for investigators.

The second building is an annex in which there are a workshop, experimental aquaria, machines, hangar, garage, special experimental equipment for the culture of microorganisms and small metazoa.

A landing for a power boat 8 meters long  
Fishing gear.

Marine material is supplied by the important fishing fleet of Sète.

*Staff:* Director, Professor E. Chatton of the University of Montpellier. Assistants: M<sup>lle</sup> B. Biecheler, Dr. Meyrueis, M<sup>lle</sup> Brachon. Technical and clerical: 1. Maintenance and operation: 2.

*Provisions for visiting investigators:* Workers are lodged at the station, fed at their own expense by

the "concierge," if desired. All the resources of the station, boat and fishermen, are at the disposal of workers.

*Income:* Sources: University of Montpellier, the State, City of Sète, etc.

Amount: About 35,000 francs annually. The personnel is paid separately.

*Provision for the publication of results:* Travaux de la Station de Sète, of which 19 volumes have appeared since 1896; they are being continued.

#### **Station Biologique de Tamaris sur Mer ('37)**

*History or origin:* Established in 1901.

*Location:* Tamaris sur Mer (Var.) near Toulon.

*Organization to which attached:* University of Lyon at École des Hautes Études.

*Purposes:* Experimental researches on marine organisms; studies of the Toulonnais littoral fauna and flora.

*Scope of activities:* Special researches in biochemistry and the electro-physiology of invertebrates.

*Equipment:* Laboratory of biochemistry, 1 room 6 m. x 6 m., 2 rooms 3 m. by 3 m.; electro-physiology, 1 room 6 m. x 6 m., 1 room 3 m. by 3 m.; museum, the collections are devoted to the fauna and flora of the roadstead of Toulon. Gasoline boat, 6 m. long, for fishing and dredging on the bottom from 2 to 25 meters in depth and for collecting plankton; one boat 6 m. long, with a glass bottom for making biological observations; and one canoe. 6 bed-chambers for workers.

*Staff:* Director, Doctor H. Cardot, Professor of Physiology of the Faculty of Sciences of Lyon. Sub-director, Doctor A. Bonnet, in charge of the courses in zoology, of the Faculty of Sciences at Lyon. Assistant, Doctor A. Jullien. 1 fisherman-caretaker.

*Provisions for visiting investigators:* The station can admit about 10 investigators, nothing is demanded of them except reimbursement for room service and from those who take lodgings.

*Income:* Sources: Regular grant from the Ministry of Public Instruction, 25,000 fr. Regular grant from l'École pratique des Hautes Études, 5,000 fr. Various subventions from scientific funds, Ministry of Marine, Director of Hygiene, etc.

*Provisions for publication of results:* None. The station sends each year a series of separates of the work published during the course of the year for purposes of exchange. 160 notes were published from 1927 to 1936

#### **Station Zoologique de l'Université de Paris à Villefranche sur Mer ('37)**

*History or origin:* Established in 1886 by Professor A. Korstneff; functioned until 1914 as a private laboratory. In 1914 it was transferred to the Russian Government and was attached to the Russian Ministry of Public Instruction. Since 1931 the station has been attached to the University of Paris.

*Location:* Villefranche sur Mer, Alpes Maritimes, France.

*Organization to which attached:* The University of Paris and functions as regards administration as an annex of the Laboratoire Arago à Banyuls sur Mer but with an autonomous budget.

*Purposes:* Study of pelagic fauna, macro- and micro-plankton, which is particularly rich in the Bay of Villefranche sur Mer and its immediate vicinity. Researches by specialists on different problems of marine biology, zoology, botany, bacteriology. Practical and theoretical instruction in zoology is given for students of the universities and the upper schools.

*Scope of activities:* Investigations on the plankton and its distribution (foraminifera, radiolaria); studies of vertical and horizontal submarine currents.

*Equipment:* Room for practical work for 30 students; laboratories for 10 separate workers; 10 large aquaria, installations for 24 research aquaria; museum of local fauna; library of 12,000 volumes; motor boat of 4 tons for collecting pelagic organisms and handling small dredges, boat with oars and sail; 8 bedrooms for 16 workers.

*Staff:* Director in common with the station and laboratory at Arago à Banyuls sur Mer, O. Duboscq, Professor at the Sorbonne. Sub-director, G. Trégouboff, radiolaria and parasitic protista. Assistant, Mr. le Docteur Roger, Étude des Mollusques. 1 mechanic, 1 fisherman, 1 woman housekeeper, 1 concierge.

*Provisions for visiting investigators:* The station can receive at one time, 30 workers of which 16 can be given lodgings. The workers of all countries are admitted on the payment of the subscription of 200 fr. per month. Workers registered in the French universities and the subjects of countries that rent work tables in the station (4000 fr. per year) are exempt from the payment of fees.

*Income:* Annual grant from the Ministry of Public Instructions, 120,000 fr.; in addition to which

is the amount derived from the hire of work tables by visiting foreigners.

*Provision for publication of results:* Travaux de la Station Zoologique de Villefranche sur Mer, in which are assembled the memoirs and the notes published in the different scientific publications based upon researches conducted by scientific investigators at the station.

**Station Zoologique de Wimereux  
(Pas de Calais) ('37)**

*History or origin:* Founded in 1874 by Alfred Giard.

*Location:* On the sea-shore, 2 km. north of the village of Wimereux (station Bains de Mer), 7 km. north of Boulogne-sur Mer, 260 km. from Paris.

*Organization to which attached:* Faculty of Science, University of Paris.

*Purposes:* Research and instruction in zoology and botany.

*Scope of activities:* Study of marine and littoral flora and fauna; all questions of biological and related subjects.

*Equipment:* 1 laboratory (12 places), annex for physiology; aquarium (sea water circulation); museum; library; 1 gasoline boat; 1 row boat; 11 sleeping rooms for workers.

*Staff:* Director, Prof. M. Caullery; Assistant, L. Callien; 1 keeper; 1 mariner during the season.

*Provisions for visiting investigators:* Lodging and table for workers. About 15 can be accommodated.

*Income:* Regular resources, about 40,000 francs.

*Provision for publication of results:* Travaux de la Station Zoologique de Wimereux, quarto, 11 volumes published, (the twelfth in course of publication).

## GERMANY TO MONACO, INCLUSIVE

### GERMANY

**Deutsche wissenschaftliche Kommission für  
Meeresforschung ('37)**

*History or origin:* The Commission was established in 1901 under the name the Deutsche Kommission für die Internationale Kommission für Erforschung der Nordeuropäischen Meere.

*Location:* Office of administrative head, Berlin W. 9, Potsdamerstrasse 10-11.

*Organization to which attached:* Reichs-und Preussisches Ministerium für Ernährung und Landwirtschaft, (at Berlin W. 8, Wilhelmstr. 72).

*Purposes:* The principal purpose is the scientific investigation of fisheries problems and those physical, chemical, and biological aspects of the sea which influence fisheries.

*Scope of activities:* 1. To understand so fully the interrelations of life processes in the sea that important questions of sea fisheries can be completely answered at any time. The work of the D. W. K. deals with (a) concrete specific problems and (b) the fundamental biological problems of fishes.

2. To obtain knowledge of the general relations of the sea, its physical conditions, its chemical composition, and its currents, especially those which may transport fish eggs and larvae, the exchange of water between the different seas and between the different parts of the same sea. The work of the Kommission therefore is based on

results obtained through hydrographic and oceanographic investigations.

3. The more restricted investigations of fisheries-biology include (a) specific parts of the sea or specific fishes, (b) special important fundamental problems. To the latter class belong the investigations of Brandt on the nitrogen relations in the sea and of von Buddenbrock on the action of different salt concentrations on life in the sea. In its international coöperative work two problems, the investigation of the races of fishes and the fluctuations in abundance, stand foremost. The work in fisheries-biology in its narrower sense is divided into that for the North Sea and that for the Baltic.

4. Another section of the work deals with fisheries statistics.

5. The D. W. K., from the beginning of the International Council for the Exploration of the Sea, till 1915, and then again since 1926, has been a member of this Council, its representatives on it being: Staatssekretär i. R. Dr. Heinrici and Professor Dr. Hagmeier.

*Equipment:* The Deutsche wissenschaftliche Kommission utilizes in its researches other institutions which have extensive equipment. They are the Biological Station on Helgoland, the Zoological Institute at Hamburg, the Deutscher Seefischerei-Verein at Berlin, and the Deutsche Seewarte at Hamburg, and has relations with the Institut für Meereskunde in Berlin. The Deutsche wissen-

schaftliche Kommission has at its disposal the research vessel POSEIDON.

*Staff:* Members of the Commission:

Vorsitzender: Dr. jur. C. Heinrici, Staatssekretär i. R.

Stellvertretender Vorsitzender: Professor Dr. Hagmeier, Helgoland.

Ehrenmitglieder: Geheimrat Professor Dr. Henking, Berlin, Professor Schott, Hamburg.

Ordentliche Mitglieder: Professor v. Buddenbrock, Halle a/S; Doctor Erich Fischer, Berlin; Professor Hentschel, Hamburg; Professor Dr. B. Schulz, Hamburg; Studiendirektor Dr. Strodtmann, Hamburg; Professor Dr. Schnakenbeck, Hamburg; Director R. Ahlf, Wesermünde.

Ausserordentliche Mitglieder: Doctor Hertling, Helgoland; Professor Dr. Witter, Berlin; Professor Dr. Wulff, Helgoland; Dr. Bückmann, Helgoland, also Secretary of the Commission.

*Provisions for visiting investigators:*

*Income:* For 1926, 100 000 RM; for 1927–1930, each year 500 000 RM; for 1931–1932 about 100 000 RM each year. These amounts do not include the expense of the operation of the vessel POSEIDON.

*Provision for publication of results:* Berichte der Deutschen wissenschaftlichen Kommission für Meeresforschung, Neue Folge. (Im Verlage der E. Schweizerbart'schen Verlagsbuchhandlung (Erwin Nägele) G.m.b.H., Stuttgart-W., Johannesstr. 3 a). In addition to the series mentioned, the Reichsministerium für Ernährung und Landwirtschaft publishes yearly a report entitled "Jahresbericht über die Deutsche Fischerei."

#### **Fischerei-biologische Abtheilung im Deutschen Seefischerei-Verein ('37)**

*History or origin:* Established in the year 1885.

*Location:* Berlin S.W. 11, Hedemannstrasse. 33.

*Organization to which attached:* Deutscher Seefischerei-Verein.

*Purposes:* 1. Investigations in fishery biology as part of the work of the International Council for the Exploration of the Sea.

2. Special investigations for particular fisheries.

*Scope of activities:* The North Sea, the Baltic, and the North Atlantic.

*Equipment:* A research ship POSEIDON and chartered fishery boats.

*Staff:* Dr. Erich Fischer; Dr. P. F. Meyer; Dr. Altnöder.

*Provisions for visiting investigators:*

*Income:* Source: Reichsernährungsministerium.

Amount: 10,000–12,000 RM.

*Provision for the publication of results:* Abhandlungen des Deutschen Seefischerei Vereins, Berichte der Deutschen wissenschaftlichen Kommission für Meeresforschung, Zeitschrift für Fischerei und deren Hilfswissenschaften und Die deutsche Fischwirtschaft.

#### **Institut und Museum für Meereskunde ('37)**

*History or origin:* Established in 1900 as the result of the efforts of Freiherr von Richthofen and others attached to the University of Berlin to establish an institute which would have for its scope the entire field of oceanography. Three published accounts of the history of the Institut are referred to in the footnote below.<sup>2</sup>

*Location:* Berlin N. W. 7, Georgenstrasse 34–36.

*Organization to which attached:* Friedrich Wilhelms Universität.

*Purposes:* Research and instruction.

*Scope of activities:* (a) Oceanographic section, physical, dynamical, and chemical oceanography, marine meteorology, continental hydrography limnology, biology, cartography.

(b) Economic geography in its widest sense, general and theoretical economic geography and economic geography of particular parts of the land; world economics, navigation, and harbors.

*Equipment:* (a) 2 buildings of three stories in Berlin. On the ground floor and the first story is a museum which contains a section for ship and machine building, navigation, features of coasts and harbors, life-saving, sea fisheries, biology, oceanography, collection of models and instruments, history of battleships.

On the second story are the work rooms of the scientific officers, laboratory, library with 20,000 books and periodicals, 15,000 separates, collection of photographs with about 12,000 negatives, collection of 6,000 cards, and instrumentarium, 1 small and 1 large lecture hall.

(b) A small one-story building on Sakrower Sea near Berlin with instruments for limnological work, 1 motor boat and 1 row boat.

*Staff:* Director, Prof. Dr. Albert Defant, o. Professor der Ozeanographie an der Universität Berlin.

<sup>2</sup> Denkschrift über die Begründung und Ausgestaltung des Instituts und Museums für Meereskunde zu Berlin, Juli, 1901.

Das Institut und Museum für Meereskunde an der königl. Friedrich Wilhelms-Universität in Berlin. (Lenz, Geschichte der Universität Berlin, Bd. III.)

Das Institut und Museum für Meereskunde an der Friedrich Wilhelms-Universität in Berlin, März, 1929.

5 Section chiefs and custodians: Biology, Professor Dr. Thilo Krumbach. Professor of economic geography, Professor Doctor Carl Troll, o. Professor der Wirtschaftsgeographie an der Universität Berlin. Oceanography, Professor Dr. Georg Wüst, a.o. Professor an der Universität Berlin. Hydrography and limnology, Dr. Lotte Möller, a.o. Professor an der Universität Berlin. Navigation and Cartography, Dr. Th. Stock.

3 Assistants: Oceanography, Dr. Günther Dietrich; Cartography, Cand. Phil. Bittelmeyer; Economic geography, Dr. R. Schottenloher.

Draughtsmen and computers; building superintendent; 4 office assistants; a few museum guards.

*Provision for visiting investigators:* Work places in the laboratory and in the library.

*Income:* At present about 40,000 R.M. without the salaries of the officers. In normal times considerably more.

*Provision for publication of results:* Wissenschaftliche Veröffentlichungen: Veröffentlichungen des Instituts für Meereskunde, Alte Folge 15 Hefte; Neue Folge: (A) Geographisch-naturwissenschaftliche Reihe, bisher 33 Hefte; (B) Historisch-Volkswirtschaftliche Reihe, bisher 11 Hefte. Volkstümliche Reihen: (a) Meereskunde, Sammlung volkstümlicher Vorträge, 205 Hefte; (b) Das Meer in volkstümlichen Darstellungen, 5 Bände.

*Mit dem Institut für Meereskunde verbunden:* (a) Archiv und Geschäftsstelle der Deutschen Atlantischen Expedition (METEOR-Expedition). (b) Herausgabe der Wissenschaftlichen Ergebnisse der Deutschen Atlantischen Expedition, bisher 14 Bände und 9 Lieferungen.

#### **Nautische Abteilung, Oberbefehlshaber der Kriegsmarine (Hydrographic Department of the Navy) ('37)**

*Location:* Tirpitzufer 72/76 Berlin, W. 35.

*Staff:* Director, Kapitän zur See Kurze.

Head of 1st Section (Books and Manuals of Maritime Sciences, Notices to Mariners, Wireless Notices), Oberregierungsrat Schellong.

Head of 2nd Section (Cartography and Surveys), Korvettenkapitän Hain.

Head of 3rd Section (General Affairs connected with Navigation), Korvettenkapitän Fallier.

Head of 4th Section (Physics and Nautical Instruments) Regierungsrat Dr. Gabler.

Head of 5th Section (Oceanography and Nautical Education), Konteradmiral a. D. Dr. Conrad.

#### *Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
METEOR.....	1,200	6	108
PEILBOOT II.....	90	1	13
PEILBOOT V.....	90	1	13

#### **Deutsche Seewarte ('37)**

*History or origin:* The Deutsche Seewarte was established in the year 1868 as the Norddeutsche Seewarte, and in the year 1875 it was taken over by the German Government as the Deutsche Seewarte.

*Location:* Hamburg 3, Alfred Wegener-Weg 1.

*Organization to which attached:* Independent, immediately subordinate to the Reichs Ministry of Communication.

*Purposes:* Investigations in the fields of navigation, instruments, oceanography and tides, meteorology, and astronomy for the promotion of maritime commerce and the economy of the sea.

*Scope of activities:* The work of the Seewarte is divided into two sections, the Nautical-Hydrographic and the Meteorological.

The work of the Nautical-Hydrographic section comprises as follows:

The collection and evaluation of observations made on ships, the testing and further development of nautical instruments and methods;

The magnetism of the earth and of ships, astronomy and time-service;

This section has charge of the library and publishes the periodicals mentioned below.

The Meteorological section has charge of a synoptical weather service for navigation and agriculture, as well as for aerial flights over the sea; maritime meteorology and the meteorology and climatology of foreign countries; the testing and development of meteorological instruments.

*Staff:* President of the Deutsche Seewarte, Konteradmiral a. D. Dr. Spiess. Other members of the staff are as follows:

Oberregierungsrat: Prof. Dr. Kleinschmidt (Abteilungsleiter Wetterdienst); Dr. von Schubert (Abteilungsleiter Nautik u. Hydrographie); Prof. Dr. Castens; R. Karbiner; Prof. Dr. E. Kuhlbrodt; Prof. Dr. B. Schulz; Dr. A. Repsold; Prof. Dr. H. Seilkopf.

Regierungsrat: Dr. Burath; Dr. Georgi; Dr. Lohr; Dr. Markgraf; Dr. Pummerer; Dr. Schumacher;

Dr. Semmelhack; Dr. Soltau; Ullrich; Lück; Oellrich; Lay.

There are also a considerable number of scientific and nautical helpers, as well as the personnel for the administration.

*Provision for visiting investigators:* For visitors engaged in scientific research a small number of work places can be provided.

*Provisions for publication of results:* Periodicals published:

1. *Annalen der Hydrographie und maritimen Meteorologie* (1937 erscheint der 65 Band).
2. *Aus dem Archiv der Deutschen Seewarte* (1937 erscheint der 57 Band).
3. *Der Seewart.*

In addition to the regularly appearing periodicals there are numerous other publications of which a list is given on the inside of the covers of the individual parts of the *Ann. d. Hydr.* and also in the *Jahresbericht der Deutschen Seewarte*.

#### Biologische Anstalt auf Helgoland ('37)

*History or origin:* Established in 1892. For its principal purposes: (1) Researches in pure marine biology by means of general biology, physical chemistry, (2) zoological and botanical investigations in the North Sea, and (3) applied biology, through investigations in the service of fisheries. In the biology of fishes the following were the principal tasks: Investigation of the fishing grounds (the configuration of the bottom, the fauna, and the production of edible fish), experiments in fish culture, researches for the purpose of ascertaining the proper limits of closed seasons for edible fish, monographic descriptions of the most important commercial fishes, and the investigation of the plankton as the basic source of food in the sea.<sup>3</sup>

<sup>3</sup> For the history of the Biological Station on Helgoland, see article by Prof. W. Mielck entitled "Die Biologische Anstalt auf Helgoland und die Seefischereiforschung": *Cons. Internat. Expl. Mer, Rapports et Procès-Verbaux des Réunions*, vol. 47, part 3, pp. 17 to 33, 1928.

Other pertinent articles are as follows:

- Mielck, Wilhelm, *Die Preussische Biologische Anstalt auf Helgoland*: In Brauer, Ludolph (et al.), *Forschungsinstitute*, vol. 2, pp. 175-199, 6 plates, 2 figures each. 1930.
- Hagmeier, A., *Aufgaben und Bedeutung der Preussischen Biologischen Anstalt auf Helgoland*: *Der Biologe*, Heft 7, 3 Jahrgang, Juli, 1934, pp. 161-166, figs. 1-4.
- Hertling, H., *Die Biologische Anstalt auf Helgoland als Meeresstation und Lehrinstitut*: *Ibid.*, pp. 167-173, figs. 5-10.
- Hagmeier, A., *Ökologische Untersuchungen der Biologischen Anstalt*. (a) *Bodenfauna*: *Ibid.*, pp. 173-174.
- Wulff, A., *Ökologische Untersuchungen der Biologischen Anstalt*. (b) *Plankton*: *Ibid.*, pp. 175-177.

*Location:* On the Island of Helgoland in the North Sea, 67 kilometers northwest from the coastal city of Cuxhaven.

*Organization to which attached:* Independent, but immediately subordinate to the Ministerium für Wissenschaft, Erziehung, und Volksbildung.

*Purposes and scope of activities:* I. In the field of marine biology and oceanography:

1. Scientific investigations especially in the North Sea and northern waters;
2. Scientific and practical work in applied oceanography (for the use of high-seas fisheries, coastal fisheries, and land reclamation);
3. Zoological and botanical marine station with work places and the supply of living and preserved material for research.

II. In the field of ornithology:

4. Ornithological station (investigation of bird migration, bird banding, protection of nature).

III. For the completion of the instruction in the universities and the advancement of teaching of natural sciences:

5. Provisions for instruction in marine biology and ornithology for students and teachers;
6. Supply of living and preserved material for instruction, and supply of North Sea animals, sea water, and algae for aquaria.

Connected with the Biologische Anstalt there are on Helgoland: An exhibition aquarium, North Sea museum, seismological station, and a work place for the representative the Deutsche wissenschaftliche Kommission für Meeresforschung.

In Wesermünde: Work places for the fisheries investigation of the Biological Institute in Helgoland and of the Institute of Sea Fisheries in Wesermünde.

*Special subjects:* Plankton, bacteriology, biology of useful fishes, oysters, lobsters, biology and physiology of other marine animals and algae, especially in their economic relations, marine fauna, fisheries biology, hydrography, marine bottom deposits, investigation of bird migra-

Schreiber, E., *Forschungen an Meeresalgen*: *Ibid.*, pp. 177-178.

Bückmann, A., *Die angewandte Meeresforschung an der Biolog. Anstalt*. (a) *Fischereiforschung*: *Ibid.*, pp. 178-180.

Erdmann, W., *Die Angewandte Meeresforschung an der Biolog. Anstalt*. (b) *Züchtung von Meerestieren*: *Ibid.*, pp. 180-182, fig. 11.

Wohlenberg, E., *Die Angewandte Meeresforschung an der Biolog. Anstalt*. (c) *Biologische Landgewinnungsarbeiten im Wattenmeer*: *Ibid.*, pp. 182-183, figs. 12-13.

Drost, R., *Die Vogelwarte Helgoland*: *Ibid.*, pp. 184-186, figs. 14-15.

tion and related problems, meteorology, registration of seismic activities.

*Equipment:* A principal building on the open sea with laboratories, collecting rooms, sorting rooms, administrative rooms, and public aquarium (seven large and fifty small tanks), 6 stories, 960 sq.m. Laboratory on the harbor 3 stories, 382 sq.m. Ornithological station 3 stories, 336 sq.m. Trapping grounds of the ornithological station 2600 sq.m. The Museum, the North Sea Museum, and Bird Migration Museum, 2 stories, 180 sq.m. Library, more than 13,000 bound volumes and more than 13,000 unbound volumes. Research ship MAKRELE, 34 m. long, 420 p.s. Diesel motor, speed 10 knots per hour (for longer voyages, the institution has at its service the Governmental research ship POSEIDON, 46 m. long). 2 motor boats. Several small row and sail boats. Several houses. Shed for fishing gear, boats, gasoline storage, etc. Seismological room, 1st order, 142 sq.m. 5 servants houses. Studentenheim "Wilh. Mielck Haus," 27 beds. Work place for the Deutsche Wiss. Komm. für Meeresforschung. Branch Laboratory in List, on the Island of Sylt, in the service of the Institute's investigation of tide lands and oysters. Im Wesermünde: work place Fischereiforschung.

The Biological Institute on Helgoland also coöperates with the Hansische Universität Hamburg (Mathematisch-Naturwissenschaftliche Fakultät), Institut für Seefischerei in Wesermünde, Forschungsstellen Westküste in Büsum and Husum, Geologische Forschungsanstalt Senckenberg, Wilhelmshaven.

*Staff:* Director: Professor Dr. A. Hagmeier. The Director is the head of the administration (Kassa and Büro, 1 inspector, 1 secretary, and three assistants), the research work, the conduct of the station, the branch laboratory at List, and the public arrangements of the aquarium and museum. He was also the editor of the Wissenschaftliche Meeresuntersuchungen, Abteilung Helgoland (now discontinued).

The heads of the sections in the Institute, and their assistants are as follows:

Ecology: Director Prof. A. Hagmeier. Scientific assistants: Dr. H. Schack, Dr. B. Werner, Dr. Ahinke (Wilhelmshaven).

Plankton: Kustos Prof. A. Wulff. Scient. Assistant: Dr. C. Künne, D.W.K.

Zoology: Kustos Dr. H. Hertling. Oberassistent

Dr. Meunier. Research Assistant: Dr. L. Jacobi.

Botany: (Kustos Prof. E. Schreiber, on leave), Substitute: Dr. P. Kornmann.

Applied Marine Research: Sekretär der D.W.K. Dr. A. Bückmann. Scientific Assistants: D.W.K. Dr. Lundbeck (Wesermünde). Dr. Schmidt, Dr. Risch (Wesermünde).

Ornithological Station: Kustos Prof. R. Drost. Scientific Assistant, Dr. Schildmacher.

Technical staff: 16 assistants for scientific work and aquarium. 9 technical staff and appointees for scientific fishery experiments; 10 officers and assistants for the office and library; 2 machinists; 6 members of the house personnel.

*Provisions for visiting investigators:* For foreign investigators there are 50 work places besides 30 places available for those who are taking courses.

*Provision for publication of results:* (a) Wissenschaftliche Meeresuntersuchungen, N.F., Abteilung Helgoland. Gr. 4°. (zitiert: Wiss. Meeresunters. Abt. Helgoland, BD. XIX, Nr. 1.) Discontinued.

Fortsetzung: Helgoländer Wissenschaftliche Meeresuntersuchungen.

(b) Abhandlungen aus dem Gebiete der Vogelzugsforschung, Gr. 4°.

(c) Der Vogelzug. (In Gemeinschaft mit der Vogelwarte Rossitten der Kaiser-Wilhelm-Gesellschaft und der Deutschen Ornithologischen Gesellschaft herausgegebene Zeitschrift.)

(d) Many scientific contributions of the Institute appear in other Zeitschriften especially in the Berichte der Deutschen wissenschaftlichen Kommission für Meeresforschung (Ber. d. D.W.K.) and in the publications of the International Council for the Exploration of the Sea.

#### Meereschemisches Laboratorium der Universität Kiel ('37)

*Location:* University of Kiel, Kiel, Germany.

*Organization to which attached:* University of Kiel.

*Purposes and scope of activities:* Study of the chemistry of sea water.

*Equipment:* One physical and one chemical laboratory.

*Staff:* Chief, Dr. H. Wattenberg; Assistant, Fräulein Dr. H. Meyer.

**Meeresgeologische Forschungsstelle der  
Universität Kiel ('37)**

*History or origin:* Founded January 4, 1936.

*Location:* Eastern shore of Kieler Förde, Baltic Sea.

*Organization to which attached:* University of Kiel.

*Purposes:* The investigation of coasts and of the sediments of the North and Baltic Seas, and other seas.

*Scope of activities:* When called for, work is done for state institutions, otherwise investigation is not restricted.

*Equipment:* Two small vessels, larger are planned; marinegeological-bottom mechanical laboratory; optical apparatus; under water photographic outfit; under water boring apparatus; collection of marine bottom samples from all seas.

*Staff:* Chief, Prof. Dr. Erich Wasmund; Assistant for geology and geotechnics, Dr. P. Groschopf; Assistant for mineralogy, Dr. K. Lamcke; Helpers, a diener, laboratory assistants, shared with the laboratory for sea-water chemistry.

*Provisions for visiting investigators:* Sufficient work rooms for visitors.

*Income:* From the State, partly private donations.

*Provision for publication of results:* Two new periodicals:

1. Kieler Meeresforschungen, Bd. 1, Kiel 1936.
2. Geologie der Meere und Binnengewässer, Bd. 1, Berlin 1937.

GREECE

**Hydrographic Office of the Navy, Navy  
Department ('37)**

*Location:* Athens.

*Staff:* Director, Capitaine de Vaisseau Hydrographe Alexandre Cryssanthis.

Assistant-Director, Capitaine de Vaisseau Hydrographe Denis Rasikotsicas.

Head of Section of Navigation, Lieutenant Spyros Maratos.

Head of Surveys and Research, Lieutenant Hydrographe D. Valtinos.

Head of Technical Section, Capitaine de Corvette, François Paxinos.

*Equipment:*

SURVEYING VESSEL	DISPLACEMENT	OFFICERS	CREW
NAUTILUS.....	404	3	38

**Marine Biological Station of Phaleron ('37)**

*History or origin:* Founded in 1914 by the Hellenic Ministry of National Economy, Athens.

*Location:* 2 Apollonos Street, Old Phaleron, Greece.

*Organization to which attached:* A state institution under the Hellenic Ministry of National Economy, Athens.

*Purposes and scope:* Investigation of the animals and plants, the study of currents, tides and temperatures, and the analysis of sea-water.

*Equipment:* Laboratory, library, and small museum.

*Staff:* The station is actively conducted by Mr. Nicholas Sperantsas. The members of the station are the following:

*President:* The Minister of National Economy.

*12 others:* 1. The Director of the Hydrographic Service of the Navy.

2. Another officer of the Royal Navy, appointed by the Minister of Marine.

3. The Director of Fisheries, Mr. D. Bitzanis.

4. The Inspector of Fisheries, Mr. G. Athanassopoulos.

5. The Director of the Marine Biological Station, Mr. Nicholas Sperantsas.

6. The Superintendent of the Geological Service.

7. The Director of the Athens Observatory.

8. The Professor of Zoology of the University of Athens.

9. The Professor of Botany of the University of Athens.

10. The Professor of Inorganic Chemistry of the University of Athens.

11. The Professor of Organic Chemistry of the University of Athens.

12. The Professor of Physics of the University of Athens.

*2 elected members.*

*Provisions for visiting investigators:* Visiting investigators are permitted to make use of all the facilities offered by the station, including the laboratory, the library, and the museum.

*Income:* The station is dependent financially on the Ministry of National Economy.

*Provisions for publication of results:* Bulletin de la Commission Thalassographique Hellenique. This Bulletin is not published regularly, but only as occasion demands and funds permit.

HUNGARY

**The Hungarian Oceanographic Institution  
(Magyar Tengerkutató Intézet) ('37)**

This institution is not functioning at present for the reason that the country has lost its only

seaport through the Treaty of Trianon, taking with it the "SMS NAJADE," which was given to Yugoslavia. The instruments used in explorations were in the Austro-Hungarian Naval Academy in Fiume, but these were lost during the fight for the port of Fiume.

There is at present a Committee working within the Magyar Adria Egyesulet (Hungarian Adriatic Association). Dr. Geza Entz is president and Dr. Julius Leidenfrost acting vice president. The latter is also the Director of the Committee. The Committee is located at Budapest, VIII, Baross utca 13. It has a library of 5,000 volumes and has a small collection of Dalmatian fishing products and sea animals.

The Committee is now working up the objects collected during the course of the 1913 and 1914 expeditions. In this work Krunoslav Babic of Zagreb and Ferdinand Pax of Breslau also take part.

#### ICELAND

##### Vitamálástjörn (Lighthouse Administration) ('37)

*Location:* Reykjavik.

*Staff:* Head of Lighthouse Office, Th. Krabbe; Assistant Lighthouse Engineer, B. Jonasson; Hydrographer, Skippherra F. V. Olafsson.

*Equipment:*

SURVEYING VESSEL	DISPLACEMENT	OFFICERS	CREW
HERMODUR.....	113	3	6

#### IRELAND

##### Department of Agriculture, Fisheries Branch ('37)

*History or origin:* Scientific investigations by the Department dealing with fisheries have been carried on uninterruptedly since the Marine Laboratory of the Royal Dublin Society was taken over by the newly formed Department of Agriculture and Technical Instruction, Fisheries Branch, in 1901.

*Location:* Dublin.

*Organization to which attached:* Oceanographic research in relation to fisheries is not carried on by a separate organization but is part of the duties allotted to the Inspectors of Fisheries.

*Purposes:* To elucidate technical and scientific questions which arise in the course of the administrative work of the Department, and to carry out original investigations on matters affecting Irish Free State fisheries.

*Scope of activities:* (a) Hydrography of the waters around Ireland; biology of sea fishes; zooplankton; biological investigation of fishing ground.

(b) Freshwater investigations on similar lines.

*Equipment:* Limited laboratory accommodation in the offices of the Department in Dublin. The use of the Department's Fishery Protection Cruiser, which is equipped for scientific research, is available from time to time. A fisheries library, including fishery biology, is maintained by the Department.

*Staff:* Biologists, Mr. G. P. Farran, chief; Mr. A. E. J. Went; Miss W. E. Frost. 1 laboratory assistant.

Assistance is periodically received from the officer of the Fishery Cruiser.

*Provisions for visiting investigators:* No permanent provision.

*Income:* Included in the annual vote for the Department.

*Provision for publication of results:* The members of the staff publish papers in various scientific periodicals.

#### ITALY

##### Istituto di Zoologia della R. Università di Catania ('37)

*History or origin:* Established in 1870.

*Location:* Catania.

*Organization to which attached:* The State, local authorities in charge.

*Purposes:* Fish in the Gulf of Catania; researches on Protozoa, Copepods, Isopods, Cirripeds, Echinodermata, etc.

*Scope of activities:* One of the two university custodians is assigned to the collection of marine animals. There are also local fishermen who are paid according to the work done.

*Equipment:* Technical library.

*Staff:* Director, Prof. Russo Achille; Aid, Prof. Filippo Dulzetto; Assistant, Dott. Luigi Patané.

*Provisions for visiting investigators:*

*Income:* Sources, R. University. Amount 8,000 lire.

*Provision for publication of results:* On subjects mentioned under purposes.

##### R. Osservatorio di Pesca marittima di Ganzirri ('37)

*History or origin:* Founded in 1928.

*Location:* Ganzirri (Messina).

*Organization to which attached:* Istituto di Zoologia della R. U. Messina.

*Purposes:* Studies on biology applied to Fisheries.

*Scope of activities:* Experimental researches.

*Staff:* Director, Prof. Giuseppe Mazzarelli; Assistant, C. Scordia.

*Income:* Sources: Ministero Agricoltura e Foreste.

#### **Istituto Idrografico della R. Marina ('37)**

*History or origin:* Established in 1872.

*Location:* Genova, Passo all'Osservatorio 4.

*Organization to which attached:* State institution, Royal Italian Navy.

*Purposes:* Physical oceanography with respect to its practical applications to navigation.

*Scope of activities:* Marine cartography and hydrographic information; terrestrial magnetism; researches in dynamical oceanography.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
AMMIRAGLIO MAGNAGHI....	2,400	16	163
OSTIA.....	708	6	94
CARIDDI.....	335	2	41

A magnetic observatory in a separate building.

*Staff:* Director, De Pisa, Capitano di Fregata.

Asst. Director, M. Grassi, Capitano di Corvetta.

Technical Secretary, G. Ghiglieri, Tenente di Vascello.

Head of Division of Chart Construction and Correction, L. Montella, Capitano di Vascello.

Head of Division of Instruments and in charge of Instrument Workshop, G. Perdomini, Capitano R.T.M.

Head of Division of Hydrography and Nautical Documents, A. Lazzarini, Capitano di Corvetta.

Head of Division of Compasses and of Magnetic Laboratory, A. Lazzarini, Capitano di Corvetta.

Head of Division of Geophysics, Professore M. Tenani.

Head of Division of Geodesy, Professore G. Forni.

Head of Division of Photo-Engraving, G. Ghiglieri, Tenente di Vascello.

30 technical and clerical assistants.

*Provision for publication of results:* Hydrographic charts, nautical instructions for Italy and dependencies; Annali Idrografici, Bollettino Idrografico, Ephemerides, Nautical Tables, Tide Tables, Publ. de Circonstance.

#### **Marine Laboratory of the Istituto di Zoologia della R. Università di Genova ('37)**

*History or origin:* Established 1772 (museum), 1910 (laboratory), renovated 1932-1933.

*Location:* Via Lungomare Lombardo 18, Genova.

*Organization to which attached:* State Institution, University of Genoa.

*Purposes:* Zoology, especially marine zoology.

*Scope of activities:* Research on Mediterranean plankton and abyssal fauna, etc.

*Equipment:* 3,000 volumes; small motor boat, private.

*Staff:* Director, Professor Ettore Remotti; Aid, Doctor Alessandro Brian, private docent; Volunteer assistant, Dr. Elisa Fischetti; Technical, 1; Servant, 1.

*Provisions for visiting investigators:*

*Income:* Source: Public and private income.

Amount: About 7,000 lire.

*Provision for publication of results:* Bollettino dei Musei di Zoologia e di Anatomia Comparata della R. Università di Genova (in collaboration with the Institute of Comparative Anatomy). 2 series, June, 1926.

#### **Istituto Centrale di Biologia Marina in Messina<sup>4</sup> ('37)**

*History or origin:* Established in 1916.

*Location:* Messina.

*Organization to which attached:* R. Comitato Talassografico Italiano.

*Purposes:* Researches in marine biology, with emphasis on biochemical, biophysical, and physiological problems, and the experimental investigation of the life histories of local organisms.

*Equipment:* Fishing boats and a motor boat, laboratories for microscopic, chemical, chemico-physical, and physiological researches. Favorable location for material for laboratory cultures.

Important library.

*Staff:* Director, L. Sanzo, Professor, Anatomy, Physiology. Assistants: Dr. A. Spartà; Dr. D. De Gaetani. Conservator, Dr. G. Cipria. Draughtsman and photographer, Mazza Filiberto. Preparator, Arena Giuseppe. Mechanic, and others for personal service.

*Provisions for visiting investigators:* The R. Comitato Talassografico Italiano offers to Italian and foreign Governments and Institutions, ten study places in the Istituto Centrale di Biologia Marina di Messina, each of them for a period of not less than one year on the payment annually of 1500 lire in gold for foreigners and 3000 lire paper for Italians. Study places may also be granted to

<sup>4</sup> Istituto Centrale di Biologia Marina in Messina, Explanatory Notice, Officine Grafiche Carlo Ferrari, 1932.

private persons for their own use and upon simple request, for periods not less than six months. The amount to be paid in advance is 800 lire gold for foreigners and 1600 lire paper for Italians. For each month in addition to six months, the monthly rate is respectively 130 lire gold and 260 lire paper.<sup>5</sup>

*Income:* R. Comitato Talassografico Italiano.

*Provision for publications of results:* Memorie; Bollettino; Monografie del R. Comitato Talassografico Italiano.

#### **Gabinetto di Oceanografia e Meteorologia (Napoli) ('37)**

*History or origin:* Founded in compliance with a Royal Decree dated May 1920, n. 1157.

*Location:* R. Istituto Superiore Navale, Napoli.

*Organization to which attached:* R. Istituto Superiore Navale, Napoli.

*Purposes:* Teaching oceanography and nautical meteorology to prospective officers in the Merchant Marine, and to future teachers in the nautical schools.

*Scope of activities:* Scientific and experimental researches.

*Equipment:* The usual apparatus for oceanographic work, such as that for chlorine titration, reversing thermometers, etc.

*Staff:* Professor Eredia, Professor of Oceanography. Scientific: Assistant N.N. Technical: 1. Maintenance and operation: 2.

*Provisions for visiting investigators:* Rooms attached to the laboratory will be available.

*Income:* Sources, R. Istituto Superiore Navale, Napoli. Amount, variable every year.

*Provision for publication of results:* The Istituto publishes *Annuario del R. Istituto Superiore Navale*, and the *Annali del R. Istituto Superiore Navale*, of which volumes 1 and 2 have been published.

#### **Stazione Zoologica di Napoli<sup>6</sup> ('37)**

*History or origin:* The Stazione Zoologica di Napoli was founded in 1872 by Anton Dohrn, a pupil

<sup>5</sup> To be purchased: Interesting faunistic materials from the Strait of Messina for scientific research work of museums.

<sup>6</sup> Kofoed, C. A. The Biological Stations of Europe, U. S. Bureau of Education Bulletin, whole number 440, pp. 9-32, 1910, gives a full account of the establishment of this station and a description of the buildings and their equipment up to 1909. Most of what is said in this publication is still valid and it has been utilized in preparing the statement here given, which has been checked by Prof. Reinhard Dohrn.

and colleague of Ernst Haeckel and docent at the University of Jena. In 1868 Dohrn made a journey to Sicily and established at Messina a small temporary laboratory for his own researches. He contemplated founding a laboratory and aquarium at that place but changed his intentions and decided to utilize Naples as the site of the station. In 1870 he procured from the City of Naples a site in the Villa Nazionale on the water front of the Bay of Naples, on the condition that he would erect a station which would remain the private property of himself and his immediate heirs for ninety years and then revert to the municipality, but which would still be used for its original purpose. The first building was begun in 1872 and completed in 1874. Toward the erection of the first building Dohrn contributed out of his private fortune 300,000 francs, the balance of the total cost of 400,000 francs was met by outside contributions. The German Ministry of Foreign Affairs first granted an annual subvention of 30,000 M., which was increased in 1888 to 40,000 M., and later at Dohrn's request reduced to 20,000 M. Because of the increased demands upon the station in 1886 its facilities were enlarged by the construction of the western block of the building, toward the cost of which the Italian and Provincial Governments contributed about 100,000 lire.

In 1903 in order to meet the needs for additional facilities for researches in comparative physiology and physiological chemistry, a new section of the building devoted in large part to those purposes was erected. The German Emperor encouraged the subscription to a fund of 300,000 M. for this purpose.

An account of the history of the Stazione immediately after the World War is given by Miss Margaret Boveri in an article entitled "Die Zoologische Station zu Neapel."<sup>7</sup> The third section of the article "Gegenwart und Zukunft," gives the essence of the struggle of Doctor Reinhard Dohrn, son and successor of Doctor Anton Dohrn, to regain the directorship of the station after the war and to get it into operation. The present arrangement for the operation of the station is indicated in this statement, under the caption, "Organization to which attached."

*Location:* In the Villa Nazionale of Naples.

<sup>7</sup> In L. Brauer, A. Mendelssohn-Bartholdy, and A. Meyer: *Forschungsinstitute, ihre Geschichte, Organisation und Ziele*, Vol. 2, pp. 578-598, 1930.

*Organization to which attached:* *Ente Morale*, Board consisting of seven members: President, the Mayor of Naples.

One member designated by the Naples Municipality.

One member designated by the Comitato Talassografico Italiano.

Three members designated by the Minister of National Education. (Three of these members are University Professors.)

Permanent member and director, Professor Reinhard Dohrn.

*Purposes:* Purely research, except that the Stazione maintains a supply department from which universities and investigators may get material for both instruction and research.

*Scope of activities:* Any kind of biological work for which material, both zoological and botanical, can be procured in the vicinity of Naples. This includes systematic biology, morphology, embryology, ecology, physiology, and physiological chemistry. In addition to the biological researches the station has also served as a base from which important investigations on marine bottom deposits and other subjects of geological significance have been prosecuted.

*Equipment:* The laboratory building is situated near the center of the Villa Nazionale. It stands 75 meters north of the sea wall and the first floor is about four meters above mean tide level. The material of which it is constructed is tufa masonry with stucco trimmings and the style is modern Italian Renaissance.

There is a basement which is about one meter above sea level, and above it rise four stories. The total dimensions of the entire building are 25 by 100 meters, and it reaches a height above ground of 16 meters. Its longer axis is along an east-west line, parallel to the shoreline. The building is composed of five sections, three of which are for laboratory purposes and two are intermediate connecting structures, but with some laboratory rooms in the eastern connecting structure. Chronologically the structure first erected is the middle one which is 25 meters wide by 33.5 meters long. It was completed in 1874. The next structure to be erected is at the west end. It was erected in 1886, and occupied an area 25 by 18 meters in dimensions. Between the middle section and this second section there is an open court; the area of which is 25 by 18 meters. It is enclosed on the ground level by

railings and on the level of the second floor it is spanned by a bridge, and is bordered on three sides and a part of the fourth by promenades. The easternmost section, the one for comparative physiology and physiological chemistry, was erected in 1903. The area of the base of this building is 25 by 33.5 meters. Between the structure erected in 1874 and the one erected in 1903 is a central court 25 by 17 meters in area, opening to the sky and reached on both sides at ground level by open archways. Above the arcades formed by these arches there are structures which are continuous on each side with the rest of the building, and there are two stories of laboratory rooms.

The total area of the floor space on the five floors is 12,725 square meters, and the total number of rooms, including passages, stairs, and attic compartments, is 259. The aquarium on the first floor of the building was completed in 1874. Kofoid, in his description of the Stazione Zoologica, has given much detail about the arrangement of the rooms, the salt water supply, and other features. It is suggested that his account of the station be consulted.

Visiting investigators are supplied with much equipment and many articles that must be purchased are furnished at cost. Living biological material is promptly provided, weather and season permitting. In general investigators are supposed to provide their own microscopes and certain other apparatus. Doctor Reinhard Dohrn has been able to make with the customs authorities at Naples an arrangement to import free of duty apparatus to be used at the station, but which will be exported within a year. Permits are issued for three months and they may not aggregate more than twelve months.

A large and very valuable library. There are over 25,000 bound volumes and about 40,000 reprints, numbers of which have been bound in volumes of related subjects.

*Staff:* Scientific: Prof. Reinhard Dohrn, Director; Prof. Silvio Ranzi, Head of the Zoological Department; Prof. E. Caroli, Zoological Assistant and Librarian; Prof. F. P. Massa, Department of Chemistry; Dr. G. Kramer, Department of Physiology.

Technical and Clerical: Secretary; Cashier; Accountant; Commercial agent.

Maintenance and Operation: 22 servants, fishermen, mechanics, workmen, etc.

*Provisions for visiting investigators:* The research tables at the Stazione Zoologica are leased at a cost of \$500.00 for a full year or the privilege of the use of a table may be obtained by appointment to some table under the control of a lessee. Numbers of the tables are at the disposal of various institutions that contribute to the support of the Stazione. Up to seventy people, including the staff, may be accommodated. Anyone desiring the privilege of working at the Stazione should correspond with its Director, Doctor Reinhard Dohrn, who will supply information not only on the facilities available for work at the Institution but also on living conditions in the city of Naples.

*Income:* About 800,000 Lire to 1,000,000 Lire a year, depending on the general economic situation, especially on account of the fluctuations of the tourist traffic (Aquarium) and the exchange rates.

Source: Aquarium; sale of preserved material; sale of publications; table rents; contributions.

*Provision for the publication of results:* (a) "Pubblicazioni della Stazione Zoologica." Contents: Papers on research work done in the Zoological Station. Number of volumes published, 12. Continuation of the Mittheilungen aus der Zoologischen Station zu Neapel, volumes 22.

(b) "Fauna e Flora del Golfo di Napoli." Monographs of animals and plants in the Gulf of Naples. Number of volumes published, 39.

#### **Istituto di Ricerche Biologiche in Rodi ('37)**

*History or origin:* Established by a Convention of 1935.

*Location:* Rodi (Egeo).

*Purposes:* Offers possibility of undertaking field researches in oceanographical, biological, and chemical sciences, as well as agricultural studies with special regard to marine biology in relation to fisheries.

*Equipment:* Laboratory equipped for biological, chemical, and physical researches. An aquarium comprising the local fauna. A library in formation.

*Staff:* Dott. C. Maldura.

*Provisions for visiting investigators:* Three rooms attached to the Laboratory.

*Income:* Sources: Ministero Agricoltura e Foreste, il Consiglio Nazionale delle Ricerche, il R. Comitato Talassografico Italiano, il Governo delle Isole Italiane dell'Egeo.

#### **R. Comitato Talassografico Italiano ('37)**

*History or origin:* Established by a special law in 1910.

*Location:* Rome.

*Organization to which attached:* National Research Council. (Viale delle Scienze Roma.)

*Purposes and scope of activities:* To this organization is entrusted the physical and chemical studies of Italian seas. It has pursued many oceanographic expeditions, among them, Exploration of the Sea of Levant, (with Austria) the Adriatic (14 cruises), Strait of Messina, Red Sea. It has created an oceanographic commission. The following institutions are subordinate to the R. Comitato Talassografico:

Istituto Centrale di Biologia Marina in Messina.  
Istituto Geofisico di Trieste.

Istituto Italo-Germanico di Biologia Marina di Rovigno d'Istria, together with Kaiser Wilhelm Gesellschaft of Berlin.

*Equipment:* Each Institute has its own library.

*Staff:* Chairman: \_\_\_\_\_. Vice Chairman: Prof. Gustavo Brunelli.

Other officers are listed separately under the individual institutes which make up the R. Comitato Talassografico Italiano.

*Income:* Ministero dell'Educazione Nazionale and Consiglio Nazionale delle Ricerche.

*Provision for publication of results:* Bollettino bimestrale; Memoirs (214 published); Monographs, Results of the cruises, periodically.

#### **Ispettorato Generale della Pesca e Divisione Amministrativa per la Pesca ('37)**

*History or origin:* Institute founded by the Law of Fishing of March 24, 1921.

*Location:* Roma.

*Organization to which attached:* Ministry of Agriculture and Forests.

*Purposes:* The regulation of the fisheries, the execution of the laws relating to fisheries, and the prosecution of scientific research for the improvement of the fisheries.

*Staff:* Ispettorato Generale della Pesca: General Inspector, Prof. Gustavo Brunelli. 1 clerk.

Divisione amministrativa per la Pesca: Chef of Bureau, Comm. Dott. Emilio Ciuffa. 4 secretaries; 3 clerks.

Provincial organizations in dependence (Laboratorio Centrale e R. Stabilimenti ittigenici).

**R. Laboratorio Centrale di Idrobiologia ('37)**

*History or origin:* Established 1924.

*Location:* Roma, Piazza Borghese 91.

*Organization to which attached:* Fisheries Office of Ministry of Agriculture and Forests.

*Purposes:* Sections of chemistry, systematics, morphology, physiology of salt- and fresh-water organisms. Is in coöperation with observers, limnological and marine, and with the Experimental Squadron of Fisheries.

*Scope of activities:* Study of fresh- and salt-waters.

*Equipment:* Library continually growing, and apparatus for chemistry, physics, and biology.

*Staff:* Director, Professor Gustavo Brunelli; Assistant, Doctor Carlo Maldura; Assistant, Dr. Lina Rizzo; Assistant, Dr. Gabriella Cannicci.

*Provisions for visiting investigators:* One place for research.

*Income:* Source, Ministry of Agriculture and Forests.

*Provision for publication of results:* Bollettino di Pesca, di Piscicoltura, e di Idrobiologia.

**Istituto Italo-Germanico di Biologia Marina di  
Rovigno d'Istria ('37)**

*History or origin:* Founded by Dr. O. Hermes in 1891. Under the Kaiser Wilhelm Gesellschaft z. Förderung d. Wissenschaften (Berlin) from 1910 to 1918. Under the R. Comitato Talassografico It. from 1918 to 1931. Since 1931 transformed into Istituto Italo-Germanico di Biologia marina.

*Location:* Rovigno d'Istria (Italy).

*Organization to which attached:* R. Comitato Talassografico (Italy) and K. W. Gesellschaft zur Förderung der Wissenschaften (Germany).

*Purposes:* Scientific, furnisher of material.

*Scope of activities:* Marine biology (morphology, ecology, physiology), fauna and flora.

*Equipment:* Laboratories, aquarium, library 12,000 volumes; two motor boats.

*Staff:* Directors: Prof. M. Sella, Prof. A. Steuer. Assistants: Doctor A. Vatova, Doctor G. Kramer. Technical and clerical: 5. Maintenance and operation: 4.

*Provisions for visiting investigators:* 18 places, granted gratuitously.

*Income:* Sources, Italian and German Governments; Amount, 300,000 lire yearly.

*Provisions for publication of results:* Two series of publications, Thalassia, and Note dell'Istituto Italo-germanico di Rovigno.

**Istituto Demaniale di Biologia Marina di  
Taranto<sup>8</sup> ('37)**

*History or origin:* Formerly Laboratorio di Biologia Marina del R. Ispettorato Tecnico del Mar Piccolo, established in 1915 at Taranto. The name was changed as indicated above in May, 1930. The construction of the new building was completed on February 10, 1931.

*Location:* Taranto, via Roma 3.

*Organization to which attached:* Under the State Ministry of Finance.

*Purposes:* Control of culture of oysters and *Mytilus* on lands belonging to the State in Mar Piccolo di Taranto.

*Scope of activities:* Biology of oysters and *Mytilus*, general marine biology, including bacteriology and parasitology; oceanography, including physics and chemistry of sea water.

*Equipment:* A large building with a basement, ground floor, and two higher floors. Complete laboratory equipment for the kinds of researches listed under scope of activities.

2 motor boats: ENRICO GIGLIOLI, 7 m. long, 1.9 m. wide, 8 hp., speed 5 knots per hour; and GALESO, 10 m. long, 2.5 m. wide, 30 hp., speed 10 knots per hour. Also 2 sail-boats.

Aquarium and 5 large tanks.

The Institute possesses for the culture of molluscs an experimental tract of 52,000 sq. meters in area in the first Seno del Mar Piccolo.

A growing library.

*Staff:* Director, Prof. Attilio Cerruti; Assistant, Dr. Emilio Vardaro; Custodian, attendant mariner, chauffeur-mechanic, and 10-12 workers on the experimental grounds for culture of molluscs in Mar Piccolo.

*Provisions for visiting investigators:* Besides various other rooms, there are 4 large rooms specially set aside for students and guests. It is intended that any special research will be conducted in the laboratory designed for that particular kind of investigation.

*Income:* Funds from the Ministry of Finances for the maintenances of boats, for the supply of water, gas, electricity, etc., and, moreover, 18,000 L per year.

<sup>8</sup>For the history of the Istituto see, Cerruti, A., L'Istituto Demaniale di Biologia marina di Taranto, Ministero delle Finanze Direzione Generale del Demanio Pubblico e delle Aziende Patrimoniali, Taranto, 1932; L'Istituto Demaniale di Biologia marina di Taranto, Riv. Biol. vol. 15, fasc. 3-4, Nov., 1933; and, L'Istituto di Biologia marina di Taranto, Intern. Revue Hydrobiol. Hydrograph., Bd. 29, Heft 3/4, 1933.

*Provision for publication of results:* Results of workers appear in Reviews, frequently under the name, "Contributions of R. Laboratorio di Biologia marina di Taranto."

#### **Istituto Geofisico di Trieste ('37)**

*History or origin:* Founded in 1920, taking the place of the "Sezione Geofisica" dell'ex-Osservatorio Marittimo.

*Location:* Trieste, Viale R. Gessi 2 (150 meters from the sea).

*Organization to which attached:* R. Comitato Talassografico Italiano (Roma) c/o il Consiglio Nazionale delle Ricerche. Viale delle Scienze, of which the Istituto is the active laboratory for physical and chemical researches.

*Purposes:* Research, cruises. Additional duties: meteorological and seismological observations.

*Scope of activities:* Dynamical and physical oceanography, chemistry of sea water.

*Equipment:* Chemical laboratory, physical laboratory, seismologic station, meteorologic observatory, library. Research boats are occasionally furnished by the Royal Navy.

*Staff:* Director, Prof. F. Vercelli, physics; Prof. M. Picotti, Chemist, chemistry; Dr. P. Caloi, Geophysics, seismology; Dr. S. Polli, assistant, physics; 2 technical and clerical; 2 maintenance and operation.

*Provision for visiting investigators:* Only occasionally (1 to 2).

*Income:* Grants from the R. Comitato Talassografico. The staff is directly paid from the same institution. In addition contributions from the National Research Council for instrumental equipment.

*Provision for publication of results:* The members of the staff publish papers in various scientific periodicals: *Memorie del R. Comitato Talassografico*; etc. The results of the cruises are published in *Annali Idrografici*, Genova; *Monografia della Commissione Int. del Mediterraneo* (two volumes).

#### **Ufficio Idrografico del Magistrato alle Acque a Venezia ('37)**

*History or origin:* Established 1908.

*Location:* Venezia.

*Organization to which attached:* Independent state institution.

*Purposes:* Research, mareographic and lagoonal, is provided in: Chemico-physical laboratory, Maritime Section, at S. Nicolò di Lido (Venezia).

The Office actually collects and elaborates the mareographs installed in the lagoons and along the Venetian shore; it also takes note of the rise and fall of water in the lagoons.

*Scope of activities:* Hydrography, meteorology, assistance in public works.

*Equipment:* Important library.

*Staff:* A director, Chairman Luigi Miliani, several civil engineers, a chemist.

*Provisions for visiting investigators:* Only occasionally.

*Income:* 1 million lire.

*Provision for publication of results:* *Bollettino Idrografico*: part 1, monthly; collections of materials of observations; part 2, annual: first elaboration of collected data; eventual publication of mareographs and studies on lagoons.

#### **LATVIA**

#### **Hidrografiska Dala, Jurniecbas Departaments, Finansu Ministrija (Hydrographic Section, Marine Department, Ministry of Finance) ('37)**

*Location:* Valdemara iela Nr. 1-a, Riga.

*Staff:* Head of the Hydrographic Section, K. Purns.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
HIDOGRAFS.....	450	2	13

#### **Hydrobiological Station of the University of Latvia ('37)**

*History or origin:* Founded in 1924.

*Location:* In the center of the city of Riga.

*Organization to which attached:* University of Latvia, of which the Station is an institute, connected with the Institute of Systematic Zoology, under one Director, Professor Dr. Embrik Strand.

*Purposes:* Major, research; instruction in oceanography.

*Scope of activities:* Researches in hydrography, on samples collected in the Gulf of Riga and in the Baltic (*cf.* *Folia Zoologica et Hydrobiologica*, I, p. 53 and 149, III, p. 250, IV, p. 58 and 271, V, p. 38 (1929-1933), VII, p. 30 (1934), VIII, p. 288 (1935), IX, p. 84 (1936)); biology and distribution of marine animals, zoo- and phytoplankton. (Also limnological researches.)

*Staff:* Scientific: Director, Professor Dr. Embrik Strand; Adjunkt, Cand. rer. nat. Viktor Ozolins; Laboratory assistant, N. Lisova. Maintenance and operation: 1.

*Provisions for visiting investigators:* Seven, in addition to the Institution's staff, can be accommodated.

*Income:* Contributions from the faculty of science of the University.

*Provision for publication of results:* Professor Dr. Embrik Strand has founded and publishes the series "Folia Zoologica et Hydrobiologica" of which eight volumes have been issued. The ninth will be completed in 1937. Moreover, papers have been published in various scientific periodicals.

#### LITHUANIA

**Susisiekimo Ministerija, Uosto Valdyba (Ministry of Communication, Harbor Office) ('37)**

*Location:* Malku gatvė Nr. 32, Klaipėda.

*Staff:* Director of the Harbour Office, Inzinierius Balys Slizys. Chief of the Technical Service, Inzinierius Vosylius Rimdzius. First assistant engineer, Inzinierius Nikalojus Stonis.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
PERKUNAS.....	194	2	10

#### MONACO

**Musée Océanographique de Monaco ('37)**

*History or origin:* Created and endowed in 1906 by S. A. S. Albert the First, Prince of Monaco, and recognized by the French Government as a public utility on May 16, 1906.

*Location:* Principality of Monaco, Monaco-Ville.

*Organization to which attached:* Branch of l'Institut Océanographique, central office of which is in Paris.

*Purposes:* Research and oceanographic exhibition.

*Scope of activities:* Researches in physical and biological oceanography (aquarium).

*Equipment:* 3 exhibition halls: (a) zoological oceanography; (b) physical oceanography; (c) applied oceanography. Large marine aquarium

(warm water animals). Laboratories and study aquaria. A small steamer, L'EIDER, length 18 meters, contains 8 beds, 4 forward, 4 aft.

*Staff:* Director, M. Jules Richard; Laboratory sub-director, MM. L. Sirvent and Dr. M. Oxner; Preparator, M. Giauffret (goes out with boat); Librarian, M. E. Comet; Skipper, M. Le Berrigand; Engineer, M. C. Calleri.

*Provisions for visiting investigators:* The Museum is open every day without exception to the public from 10-12, 2-5, from February 1 to October 31; 2-4 from November 1 to January 1. An entrance fee of 8 francs gives the privilege of visiting exhibition halls and aquaria. Use of the laboratories is granted to scientific men and investigators of all nationalities, permission for which is obtained upon written request to the director, indicating the nature and purpose of the work contemplated. Scholarships have been established by the founder and the Council of Administration to permit workers to spend definite periods (usually one month) at the Museum. These are granted by the Council of Administration and the Committee of Perfectionnement, on approval of the director. Workers are permitted to make expeditions on L'EIDER on certain days and hours fixed by the director.

*Income:* Sources: Derived mostly from admission fees. The funds left by S. A. S. Albert were affected adversely by the decline in the franc. Budget is a part of that of l'Institut Océanographique.

Amount: For 1931 the amount was about 860,000 francs.

*Provision for publication of results:* Bulletin de l'Institut Océanographique, Carte Générale Bathymétrique des Océans, second edition. Les Résultats des Campagnes Scientifiques de S. A. S. Prince Albert Ier de Monaco.

#### NETHERLANDS TO YUGOSLAVIA, INCLUSIVE

##### NETHERLANDS

**Koninklijk Nederlandsch Meteorologisch Instituut, Section of Oceanography and Maritime Meteorology ('37)**

*History or origin:* January 31, 1854.

*Location:* De Bilt.

*Organization to which attached:* Ministry of Public Works (Waterstaat).

*Purposes and scope of activities:* Research in meteorology, oceanography, and geophysics, and

application of the results in the special interest of agriculture, oceanic and aerial navigation, industry and commerce.

The recent expedition of the WILLEBRORD SNELLIUS to the Netherlands East Indies was organized by two scientific societies, but under the leadership of Commander van Riel, then director of the section of oceanography and maritime meteorology.

*Equipment:* Full equipment for meteorological and geophysical research at De Bilt, for meteorology

also at four other observatories. Some oceanographical instruments available. Instruments for research in meteorology on the oceans are owned by the ships' companies.

*Staff:* Director in chief of Institute, Prof. E. van Everdingen, Jr. Section of Oceanography, Director Comm. H. Keyser; Dir. Adj. Lr. Comm. J. A. van Duynen Montijn. Technical and clerical, 7.

*Provisions for visiting investigators:* Reading room and library assistance available.

*Income:* Sources: From State funds.

Amount: Budget of *whole Institute* fl. 187,148.-.

*Provision for publication of results:*

#### *Large publications*

K.N.M.I. No. 104. Oceanographische en meteorologische waarnemingen in den Indischen Oceaan; Tabellen, Kaarten, Supplementen.

K.N.M.I. No. 110. Oceanographische en meteorologische waarnemingen in den Atlantischen Oceaan; Tabellen en Kaarten.

K.N.M.I. No. 115. Oceanographische en meteorologische waarnemingen in de Chineesche Zeeën en in het westelijk gedeelte van den Noord Stillen Oceaan; Kaarten.

*Yearly publications* (provisionally suspended)

K.N.M.I. No. 107, 107<sup>a</sup>, 107<sup>b</sup>. Monthly Meteorological Data for 10° squares in the Oceans.

#### *Miscellaneous*

K.N.M.I. No. 102. Mededeelingen en Verhandelingen.

(Results of some oceanographic observations made by the Fishery Service in the North Sea are published in the Bulletin Hydrographique of the Int. Council for the Exploration of the Sea, Copenhagen.)

### **Zoölogisch Station der Nederlandsche Dierkundige Vereeniging ('37)**

*History or origin:* The original Station of the Netherlands Zoological Society, dating from 1876, was a small wooden building. It was used during summer only and was erected every year at another place on the Dutch coast. It was thus in operation from 1876 until 1889 and much work, famous then, was done in it, e.g. the oyster-investigations in the river Schelde.

In 1890 a brick building was erected at Den Helder, at the principal out- and inlet to the Zuiderzee. The building was the private property of the Zoological Society, but the main-

tenance of the Station was made possible through governmental support only. The Government namely hired most of the rooms for its new Rijksinstituut voor Biologisch Visscherijonderzoek (Government Institution for biological Fisheries Research). Dr. P. P. C. Hoek, well known as a fisheries expert, a carcinologist, and for his work as a secretary to the International Council for the Exploration of the Sea, became director of both Fisheries Research Institution and Zoological Station.

In 1902 was given to the Fisheries Research Institution the execution of the Dutch part of the program of the International Council and from that year onward a staff of investigators worked at Den Helder for a number of years: Dr. J. Boeke, Dr. P. J. van Breemen, Dr. H. C. Delsman, Dr. A. C. J. van Goor, Ir. F. Liebert, Dr. W. E. Ringer, and Dr. J. J. Tesch, while Dr. H. C. Redeke was in charge of the work. But from about 1912 onward and especially during and after the war the fine organization was gradually broken down, the work became more and more decentralized and most of the marine biological part of it came to an end. From 1926-1928 the investigations on fresh water fisheries only remained at Den Helder.

In 1928 this last part of the Institution too, still with Dr. Redeke as director, was taken away from Den Helder and the Zoological Station became free. The Netherlands Zoological Society now obtained governmental support for the reorganization of the Station. From 1931 onward it became a Marine Biological Laboratory for purely scientific work under the Ministry of Education, Arts, and Sciences, with Dr. J. Verwey as director. Stress was laid on close coöperation with the Dutch Universities.

The building was modified, a small but good aquarium installed, a ship built, and now the laboratory provides good possibilities for scientific research. From 1937 lodgings for investigators is provided.

*Location:* Den Helder, Holland, at the mouth of the Zuiderzee.

*Organization to which attached:* The Station, boat, library, are all the property of the Netherlands Zoological Society, but the Government (Ministry of Education, Arts, and Sciences) provides most of its support.

*Purposes:* Marine biological investigations in the widest sense. The Station at the same time

represents the marine laboratory for students as University Extension.

*Scope of activities:* Marine biological, ecological, physiological investigations in the southern North Sea, especially the neighborhood of Den Helder. Den Helder is a naval base and advantages are derived from the presence of the Navy. The investigations from 1931 onward have specially dealt with a number of physiological investigations, with bio-ecological problems of some invertebrates and algae, and with investigations on growth, maturity, and migrations of some cephalopods and fishes.

*Equipment:* Laboratory building with chemical laboratory, library, aquarium, rooms for investigators, etc. Research vessel MAX WEBER, a small cutter of 13 meters length.

*Staff:* Scientific: Director, Dr. J. Verwey. Students and lecturers from the four Dutch universities work at the Laboratory especially from May to October, but a few practically all the year round.

Technical and clerical assistants: 3.

Maintenance and operation: 2, including skipper of boat.

*Provisions for visiting investigators:* From 1937 onward lodgings for 9 persons can be provided. Laboratory can accommodate fifteen investigators, except during a few weeks in summer when courses for students are being held, when ten can be accommodated.

*Income:* 12,700 Dutch florins, chiefly from the Ministry of Education, Arts and Sciences, and further from some more or less private sources.

*Provision for publication of results:* Archives Néerlandaises de Zoologie (the journal of the Dutch Zoological Society). In it papers from other institutions also appear.

#### **Department van Defensie Afdeeling Hydrografie (Department of Defense, Hydrographic Section) ('37)**

*Location:* 147, Badhuisweg, 's Gravenhage.

*Staff:* Hydrographer, Schout bij nacht J. C. F. Hooykaas; Assistant Hydrographer, Kapitein luit. ter zee R. van Tijen.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
TYDEMAN.....	1,160	8	96
WILLEBRORD SNELLIUS.....	930	8	76
EILERTS DE HAAN.....	312	3	13
HYDROGRAAF.....	260	3	13
ERIDANUS.....	996	8	80

#### **NORWAY**

#### **Fiskeridirektoratet, Avdeling for Havundersökelse (Marine Research Branch) ('37)**

*History or origin:* Established 1900.

*Location:* Fosswinckelsgate 6 & 8 (Marine Biological Laboratory), and Fosswinckelsgate 11 (Oceanographical Laboratory), Bergen.

*Organization to which attached:* Fisheries Directorate, under the Ministry of Commerce.

*Purposes:* Marine research.

*Scope of activities:* Indicated under the staff, after names of advisors and assistants.

*Equipment:* 2 research vessels:

The JOHAN HJORT, a motor cutter of 70 tons gross, length 78 feet, engine (semi-Diesel, 2 cyl. 2 str.), 120 hp., speed 9 knots, crew 7, including skipper and cook, staff generally 3-4, maximum 5, in commission 10 months.

The VIRGO, a motor launch of 35 feet, engine 30 hp., speed 8 knots, crew 2, staff 2, (for fjord work), in commission 2-3 months during several shorter periods.

*Staff:* 3 advisors: Mr. Paul Bjerkan, biology of sprat, plaice etc.; Dr. Sven Runnström, herring biology; Mr. Oscar Sund, biology of cod and other gadoids. 2 biological assistants: Mr. Gunnar Rollesfsen (biology of the cod); Mr. Einar Koefoed (fish larvae, etc.). 1 oceanographical assistant, Mr. Jens Eggvin. 2 technical assistants: Mr. Thv. Rasmussen (draughtsman and herring age determination, etc.); Mr. Kr. Wilhelmsen (salinity determination etc.). 3 clerical assistants. 2 technical assistants.

*Provisions for visiting investigators:* Only improvised.

*Income:* Source: From the government, Amount: About kr. 85,000. From funds, about kr. 70,000.

*Provision for publications of results:* Publication: Report on Norwegian Fishery and Marine Investigations. (Fiskeridirektoratets Skrifter, Ser. Havundersökelsen.)

#### **Det geofysiske Institutt ('37)**

*History or origin:* Established in 1917. A building was erected in 1926-28 by contributions chiefly from States Minister Mowinkel.

*Location:* City of Bergen, near Puddefjord.

*Organization to which attached:* Bergens Museum, of which the institution is a department.

*Purposes:* Research on geophysical problems and instruction in various branches of geophysics.

*Scope of activities:* Researches in physical and dy-

namical oceanography, meteorology, terrestrial magnetism, and related subjects.

*Equipment:* 1 large building 210 feet by 44 feet. 2 stories and basement throughout. 3 stories over central part with a large pent-house on top. A tunnel, 360 feet long and 16 feet wide in the rock 50 feet below the basement.

1 research vessel: ARMAUER HANSEN, 57 tons gross, 76 feet long, 19 feet beam, motor 2 cyl. 2 str., 80 hp, speed 8 knots, complete outfit for sailing.

1 motor launch (Arnulf).

*Staff:* Scientific: Director, Prof. Dr. B. Helland-Hansen (oceanography); Prof. Dr. J. A. B. Bjerknes (meteorology); Prof. Dr. B. Trumpy (terrestrial magnetism and cosmical physics); Dr. J. E. Fjeldstad (mathematics); Dr. H. Mosby (physics); Mr. K. F. Wasserfall (terrestrial magnetism). Maintenance and operation: 6. Clerical and technical assistants: 9.

*Provision for visiting investigators:* 10 can be accommodated.

*Income:* Sources: From the State and other sources. Amount: Financial year 1935-36, Kr. 120,000.

*Provision for publication of results:* Bergens Museum's publications and Geofysiske Publikasjoner.

#### **Statens Fiskeriforsøksstasjon. (Official Norwegian Fisheries Research Station) ('37)**

*History or origin:* Founded in 1891. Attached to Fisheries Directorate in 1899.

*Location:* Thormøhlensgt. 66, Bergen.

*Organization to which attached:* Fisheries Directorate.

*Purposes:* Investigations concerning the fishing industry. Improvement of known processes and development of new. Scientific research and application of science to practice.

*Scope of activities:* The fisheries and all products and problems connected with these. Also cold storage of Norwegian fruit.

*Equipment:* Rather overcrowded old, wooden building. Chemical laboratories with ordinary, good equipment, as balances, microscopes, autoclaves, refractometers, Hilger vitameter, tintometers, precision viscosimeter, centrifuges, divers other equipment. Experimental cold store with 10 chambers, temperatures down to  $-20^{\circ}\text{C}$ . Library with most modern literature concerning the scope of activities of the station, 30-40 technical and scientific periodicals.

*Staff:* Permanent staff: Director: Chemical engineer Olav Notevarp. Konsulent: Chemical engineer Harald Weedon. Assistant: Sverre Hjorth-Hansen. Assistant: Technical chemist Alfred Monssen. Laboratory assistant:

Temporary staff: 4 chemical engineers, 1 mechanical engineer, 1 civil engineer, 4 technical chemists, 6 other assistants. (Note: All "engineers" are technical university graduates.)

*Provisions for visiting investigators:* Poor, as building is very crowded.

*Income:* Permanent budget; Temporary budget. Source: Norwegian Government.

*Provision for publication of results:* Årsveretning vedkommende Norges Fiskerier, Fiskeridirektoratets skrifter, serie Teknologiske undersøkelser. (Report on Technological Research concerning Norwegian Fish Industry.)

#### **Universitetets biologiske stasjon, Drøbak ('37)**

*History or origin:* Established 1894.

*Location:* On the Oslo-fjord in the village of Drøbak, about 30 km south of the city of Oslo.

*Organization to which attached:* University of Oslo, of which the station is a special department.

*Purposes:* Instruction: General instruction in marine zoology and botany, and in elementary micro-anatomical research methods.

General purpose: Marine research in every direction as well as biological laboratory work.

*Scope of activities:* Biology: plankton, fishes, bottom fauna and flora, microscopic anatomy, ecology.

*Equipment:* One building, 3 floors, crossbuilt, area 100 sq. m. 1 research motor boat, 30 feet, equipped to work to a depth 100-150 fathoms in the neighborhood of the station.

*Staff:* Scientific: Director, Prof. Dr. Hjalmar Broch. Teaching committee: The Director and Prof. Dr. Kristine Bonnevie; Prof. Dr. H. H. Gran; Prof. Dr. Johan Hjort; Prof. Dr. Otto Lous Mohr. Maintenance and operation: 1.

*Provisions for visiting investigators:* 3 tables.

*Income:* Source: Yearly income from the Norwegian State.

Amount: Kr. 2,200.

*Provision for publication of results:* No special publications.

**Bergens Museums biologiske stasjon (Marine Biological Station of the Bergen Museum)<sup>9</sup> ('37)**

*History or origin:* Erected in 1920-22 to take the place of a small station on Puddefjord in Bergen. The latter station was erected in 1891 but, because of the contamination of the water around Bergen, it was found necessary either to abandon the station or to find a site for a new one.

*Location:* On the Island of Herdla on Herlø Fjord, 27 kilometers north of Bergen. As the water here does not freeze during the winter, investigations may be prosecuted throughout the year.

*Organization to which attached:* Bergen Museum, zoological department.

*Purposes:* Instruction and research in Marine Biology.

*Scope of activities:* As far as possible to carry through all-sided marine research by facilitating the research possibilities of visiting scientists. The institution in itself has no special tasks, the members of the staff working with their personal problems.

*Equipment:* 1 laboratory building. The ground floor contains 3 double and 2 single laboratories and a big room for courses of instruction. When no courses are going on this room is arranged so as to give accommodations for 5 research workers. The upper floor contains the library and 9 bedrooms, 8 double and 1 single, for visitors. The basement contains tanks for keeping somewhat large organisms, an engine room, etc. This main part of the building is 12.3 meters broad and 19.3 meters long. At one end of the building a smaller section has been added, the ground plan of which is 8.2 meters by 9.3 meters in dimensions. It contains a mess-room for the scientists and an apartment for the keeper of the station.

There is an excellent salt-water system and also a fresh-water reservoir, which provide for a variety of investigations. Among the rooms aside from those of more general purposes, the laboratory for physiology and hydrography and the room for balances and chemical supplies should be mentioned.

There is also a research vessel, the HERMAN FRIELE, which is about 23 tons gross, 4.27 meters

<sup>9</sup> For full information on the Biological Marine Station of the Bergen Museum, see August Brinkmann, "Die neue biologische Meeresstation des Museums zu Bergen," Bergens Museums Aarbok 1921-22, Naturvidenskabelig Raekke, Nr. 1.

beam and 14.5 meters long. The height of the side above the water is 2.13 meters. The station possesses a motor launch and several row boats.

*Staff:* Director, Professor Dr. August Brinkmann, the chief of the Zoological Department of the Bergen Museum. Amanuensis, cand. real. Ditlef Rustad. 2 technical assistants.

*Provisions for visiting investigators:* During the summer when no classes are being given, ten visitors can be accommodated. In the winter there are provisions for five. The work places are free to all competent visitors, but Norwegians have preferential rights. With a table, there is supplied the necessary material, aquaria and ordinary laboratory equipment, together with a small quantity of the most common chemicals and dyes. The cost of consumption above this must be met by the visitor himself; although certain chemicals—upon agreement—can be obtained at cost from the laboratory's supplies. Visitors must bring their own optical and dissecting instruments, as well as all special apparatus, and must likewise provide themselves with glassware for the preservation of material which they take with them from the Station (the laboratory's glassware can not be taken).

*Income:* Source: From the State. Amount: About kr. 25,000 per year.

*Provisions for publication of results:* The usual medium of publication is in the reports of the Bergen Museum (Bergens Museums Årbok; B. M. Skrifter).

Papers published elsewhere after agreement with the Director must give plain indication, either in the title or in the introduction, that the work has been made at the Station, and separate copies must be sent to the Station.

**Sjøkartverket (Nautical Charts Office) ('37)**

*Location:* Oslo.

*Staff:* Director, VPL. Premier Loitnant Rolf Kjaer. Head of 1st Section (provisional) (Calculation, construction, drafting, etc., of new charts, editions) VPL Kaptein J. Z. Lundquist, R.N. (retired).

Head of 2nd Section (Keeping up to date of plates and charts, coloring of light sectors) Kommandörkaptein A. Boehmer, R.N.

Head of 3rd Section (Notices to Mariners, Sailing Directions, Library) VPL Kaptein S. Bjerknaes, R.N. (retired).

In charge of Vessels, Archives of originals and plane-tables, Kaptein H. A. Buhre, R.N. (retired).

Magnetic work, Instruments, Tides and Currents, Løitnant F. Vogt, R.N.R.

In charge of special work, Løitnant R. Kjaer, R.N.R.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
HYDROGRAF.....	98	1	5
WILHELM HUTH.....	98	1	5
ROST.....		1	4

7 accommodation vessels, 9 motor boats.

**Tromsø Museum ('37)**

*History or origin:* Founded 1872.

*Location:* Tromsø.

*Organization to which attached:* Independent.

*Purposes:* Biological and archeological investigations and museum. Hydrographical laboratory and investigations in connection with the biological researches. Regular hydrographical investigations of the Tromsø area.

*Equipment:* 1 boat SPARRE SCHNEIDER, 38 feet, with necessary equipment. Laboratory for chemical and colorimetric determinations.

*Staff:* Director, Mr. Soot Ryen. Scientific: 2. Technical and clerical: 2. Maintenance and operation: 1.

*Provisions for visiting investigators:* None.

*Income:* Sources: State and other receipts.

Amount: Kr. 26,000.

*Provision for publication of results:* Tromsø Museums Skrifter.

**Trondheims Biologiske Station ('37)**

*History or origin:* Founded in 1900.

*Location:* Trondheim.

*Organization to which attached:* Private, subsidized and controlled by the State.

*Purposes:* Hydrographical and biological investigations in the fjords and coasts.

*Scope of activities:* Coastal water and adjacent ocean. Hatching of plaice.

*Equipment:* 1 boat, GUNNERUS, motorship.

*Staff:* Director, Mr. C. F. Dons; Technical and clerical, and maintenance and operation 3.

*Provisions for visiting investigators:* Accommodation for four students.

*Income:* Sources: Private, Municipal and State subvention.

Amount: Kr. 28,000.

*Provision for publication of results:* "Meddelelser" (Published by Det Kgl. Norske Vidensk. selskab, Trondheim).

POLAND

**Biuro Hydrograficzne Marynarki Wojennej  
(Hydrographic Office of the Navy) ('37)**

*Location:* u. Chalubinskiego, 3, Warsaw.

*Staff:* Hydrographer, Komandor podporucznik Arthur Reyman.

Head of Surveys and Researches, Kapitan Marynarki Ignacy Pogorzelski.

Head of Supply Service for Navigation, Porucznik Marynarki Tadeusz Borysiewicz.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
POMORZANIN (ex- MEWA).....	200	3	37

PORTUGAL

**Aquário Vasco da Gama-Estação de Biologia  
Marítima ('37)**

*History or origin:* Built in 1898 as a public Aquarium for the series of ceremonies in commemoration of the fourth centenary of the voyage of Vasco da Gama to India. After the ceremonies, the building was delivered to the State (Ministry of Marine, to whom is assigned the administration of Navigation and Fisheries). Later on, about 1908, the "Sociedade Portuguesa de Ciências Naturais," whose aim is the promotion of research in scientific natural history, took charge of the building in order to establish in it a marine biological station. After many difficulties, owing to shortage of funds and to the Great War, the Ministry of Marine again took charge of the station and it was officially organized (May, 1919) as an independent scientific institution for the study of the sea, mainly connected with fisheries.

*Location:* Dâfundo, near Lisbon, about 10 km from the mouth, on the right margin of the River Tagus.

*Organization to which attached:* Connected with the Fisheries Administration of the Ministry of Marine. Autonomous administration by a board formed by an officer of the Navy, as President, appointed by the Ministry, the Director and Naturalist of the Station, and a secretary.

*Purposes:* General research on the sea near Portugal (biology and oceanography).

*Scope of activities:* Researches in oceanography near

Portugal, eventually carried to a distance, as for instance near Madera, the Straits of Gibraltar, and the Morocco Coast. Biology of useful fishes (sardine, tunnies, hake) and of plankton.

*Equipment:* 1 laboratory building (same as the public aquarium), 1 floor with eight rooms used as individual laboratories.

*Library.* The resources of the University of Lisbon and the libraries of its different institutes are more or less available for the workers, as a supplement to the limited facilities at the aquarium. Tank rooms for fresh and brackish water animals.

*Staff:* Director, Dr. Alfredo Ramalho. Naturalists, R. Bôto, B. Gonçalves, and H. Vilela. 2 clerical and technical assistants. 2 maintenance and operation workers. For aquarium: 2 engineers; 5 fishermen; 1 guard.

*Provisions for visiting investigators:* There is room for 2 or 3.

*Income:* For 1936 the total receipts amounted to about 240,000 Escudos (one Escudo equivalent, at the present rate of exchange, to about 5 U. S. A. cents). 200,000 from the State and the remaining from the entrance fees in the aquarium (40,000 visitors, not taking account of the pupils of schools).

*Provisions for the publications of results:* The papers are generally published in different journals, only exceptionally printed by the Station. All are distributed in exchange to similar scientific institutions as "Travaux de la Station de Biologie Maritime de Lisbonne."

*Research Ship ALBACORA:* A ship of the same type and dimensions of ARMAUER HANSEN of the Geophysical Institute of Bergen; displacement about 135 tons, with sails and 60 H.P. motor; winches for work to a depth of about 3,000 meters; small laboratory. Built in 1924, in Norway, under the scientific supervision of Professor B. Helland-Hansen, of the Geophysical Institute in Bergen. The ship belongs to the Portuguese Navy.

**Direcção de Hidrografia, Navegação e Meteorologia Nautica (Office of Hydrography, Navigation and Nautical Meteorology) ('37)**

*Location:* Navy Department, Lisbon.

*Staff:* Director, Capitão de Mar e Guerra Augusto Fernandes Lopes.

Head of 1st Division, Capitão de Fragata Manuel da Cunha Rêgo Chaves.

Head of 1st Section, Capitão de Corveta Amadeu Julio de Sousa Correia.

Assistant of the 2nd Section, Primeiro tenente Manuel Zagalo da Silva.

Assistant, 3rd Section, Capitão de Fragata Artur José da Conceição Santos.

Head of 2nd Division (Nautical Meteorology) Capitão de Fragata João Antonio Correia Pereira.

Heads of Sections, Meteorologists Primeiro tenente Joaquim da Costa and Primeiro tenente José Mendes da Rocha Zagalo.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
5 D'OUTUBRO.....	1,365	10	89
ALBACORA.....	135	1	14
BÉRRIO.....	498	5	48
BEIRA.....	405	5	27

**RUMANIA**

**Romania, Serviciul Hidrografic al Marinei de Razboi (Hydrographic Service of the Navy) ('37)**

*Location:* Constantza.

*Staff:* Chief of the Hydrographic Service, Capitan Alexandru Stoianovici.

**Statia Zoologica Maritima "Regele Ferdinand I" (Maritime Zoological Station "King Ferdinand I") ('37)**

*History:* Founded by Prof. I. Borcea of the Faculty of Science at Iasi on March 1, 1926, with the assistance of the Ministers of Public Instruction, Dr. C. Angelescu and Dr. N. Lupu, and through the efforts of Prof. A. P. Baznosanu of the Faculty of Science in Bucharest.

*Location:* Village of Agigea, Province of Constantza, between the railroad station "General M. Ionescu" and Eforia baths.

*Organization to which attached:* Ministry of National Education, Zoological Laboratory of the University of Iasi.

*Purposes:* In particular the knowledge of the fauna of the Black Sea and of the neighboring lakes. The completion of students' zoological education.

*Equipment:* Two principal buildings, one for the Director and one for the investigators; two smaller buildings, one for the administration and one for students (laboratory); and a small electrical plant. There are about 22 hectares of land. The equipment otherwise is very limited, a few mud dredges and a motor boat.

*Staff:* Scientific: Director, C. Motas, Professor of Zoology, University of Iasi.

Chief of Laboratory, Mrs. Dr. Lucia Borcea.

Assistant: Mr. Sergiu Carausu.

Administrative: An Administrator, a laboratory worker, two servants.

*Provisions for visiting investigators:* Two work tables, free lodging, food to be bought at the Station's restaurant which operates from June 1 to October 1.

*Income:* None.

*Results of investigations* are published in the review, *Annales scientifiques de l'Université d'Iassy* (authors receive 50 copies free).

#### SCOTLAND

##### Marine Laboratory of the Fishery Board for Scotland ('37)

*History or origin:* Established in 1882.

*Location:* Aberdeen, Scottish east coast—principal trawl and great line-fishing port in Scotland.

*Organization to which attached:* Fishery Board for Scotland.

*Purposes:* Fishery biological research.

*Scope of activities:* The study of the stocks of marketable fishes and crustaceans in general, of the haddock, herring, and plaice species in particular and of all factors biological and physical affecting such stocks. Operations are carried out consistently over the whole continental plateau to the north of approximately Lat. 55°30' N. Occasional trawling, planktonic, and hydrographic surveys also being made to Faroe and Iceland waters.

*Equipment:* One laboratory building, Wood Street, Terry, Aberdeen, "H" shaped, single floor, includes museum of marine fauna and large library of relevant literature.

One aquarium building, Bay of Nigg, Aberdeen, with out-buildings (pumping machinery, store rooms, etc.), tidal pond, two large concrete seawater storage tanks.

One deep-sea research vessel *EXPLORER*, Mersey class trawler, length 138 feet, breadth 21 feet, gross tonnage 324 tons, fitted with modern trawling gear, echo sounder, and necessary oceanographic research equipment.

*Staff:* Scientific: Superintendent, R. S. Clark, M.A., D.Sc., F.R.S.E. Naturalists, Senior Grade: H. Wood, M.A., Ph.D.; J. B. Tait, B.Sc., Ph.D., F.R.S.E. Naturalists, Junior Grade: S. G. Gib-

bons, B.Sc., Ph.D., F.R.S.E.; D. S. Raitt, B.Sc., Ph.D., F.L.S., F.R.S.E.; A. Ritchie, B.Sc., Ph.D.; B. B. Rae, B.Sc.; J. H. Fraser, M.Sc. (probationer naturalist).

There are nine technical assistants and five non-technical helpers.

*Provisions for visiting investigators:* No special provision exists for visiting investigators.

*Income:* Finances entirely by H. M. Government.

*Provision for publication of results:* A survey of each year's work with the general application of results is published annually in the Board's report. More detailed reports of particular researches are issued separately in a series referred to as "Fisheries Scotland, Sci. Invest." All publications issued by the Board are printed and published by H. M. Stationery Office, 120 George Street, Edinburgh. On account of Scotland's participation in the work of the International Council for the Exploration of the Sea reports and data relating to Scottish work also appear in the publications of that body.

##### The Torry Research Station ('37)

*History or origin:* Established in 1929.

*Location:* Aberdeen, Scotland.

*Organization to which attached:* The Department of Scientific and Industrial Research. The Torry Research Station is under the aegis of the Food Investigation Board of the Department. Headquarters, 16 Old Queen Street, Westminster, London SW 1.

*Purposes and scope:* Investigations of methods of handling, stowage, transport, storage and, in general, the preservation of fish and food. Researches into the associated basal physiological and biochemical problems.

The Station's work is largely coördinated with researches connected with food at other organizations under the Department of Scientific and Industrial Research. Coöperation in similar Empire researches is maintained.

*Equipment:* A two story brick building, in Abbey Road, Torry, Aberdeen, containing offices and laboratories. A two story building of shed construction close by, containing experimental plant (cold stores, smoke curing kilns, oil extracting apparatus), further laboratories, workshops.

A research vessel—*CITY OF EDINBURGH*—a steam drifter adapted for trawling and for certain laboratory operations, 84 ft. long, 18 ft. beam, 88 gross tonnage.

*Staff:* Superintendent, Adrian Lumley. Senior Scientific Officers: George A. Reay, M.A., B.Sc., Ph.D.; J. A. Lovern, B.Sc., Ph.D. Junior Scientific Officers: J. Shewan, B.Sc., Ph.D.; A. Banks, B.Sc., Ph.D. 7 Technical and Laboratory assistants; 16 Industrial staff.

*Provisions for visiting investigators:* No special provision.

*Income:* Financed entirely by H. M. Government.

*Provision for publication of results:* Survey of each year's work appears in the Annual Report of the Food Investigation Board. Occasionally special reports (on particular researches) and leaflets (for information of the fish industry) are published.

These above are printed and published through H. M. Stationery Office, Adastral House, Kingsway, London, W.C. 2.

Scientific papers are published under authors' names in various scientific and technical journals, e.g. "Biochemical Journal," "Analyst," "Journal of the Society of Chemical Industry," "Ice and Cold Storage."

#### **Marine Biological Station, Keppel Pier, Millport ('37)**

*History or origin:* The original laboratory was a barge the ARK brought from the Forth by Sir John Murray in 1885, and drawn up on the shore near the present site. The ARK, replaced by a stone building in 1897, was destroyed by a storm in 1900.

*Location:* Near Keppel Pier, on the south east corner of Cumbrae Island in the Firth of Clyde; about 1 mile from the town of Millport.

*Organization to which attached:* Scottish Marine Biological Association.

*Purposes:* Investigation of the fauna and flora of the Clyde Sea area and provisions of facilities for research and study for students and others interested in such work.

*Scope of activities:* Plankton investigations, growth of the diatom crop in relation to *Calanus*; growth, distribution, etc. of *Calanus* in relation to physico-chemical factors; growth, food and distribution of young herring, leading to the elucidation of the food chain on which the herring fishery depends.

Quantitative studies of bivalves and crustacea in sandy bays in relation to the food supply of inshore fishes.

*Equipment:* Laboratory building, two floors, 30 feet by 75 feet with 30 foot wing. Fresh sea water, gas, electric light and power. The labora-

tory contains a Public Museum and Aquarium. Library approximately 1500 volumes and 2000 pamphlets.

A motor boat M. B. NAUTILUS, 40 feet long, 12 tons, 30 h.p. engine, equipped for trawling, sounding, townetting, etc. At the Station is an 18 foot boat with 3½ horse outboard motor.

*Staff:* Scientific: Director, Richard Elmhirst; Biochemist, A. P. Orr, M.A., D.Sc., A.I.C.; Naturalist, Miss S. M. Marshall, D.Sc.; Assistant Naturalist, Aubrey G. Nicholls, Ph.D. Maintenance and operation: Foreman, J. Peden; Laboratory Assistant, E. Latham; Skipper and boatman, R. Kerr; Museum attendant, J. Shields; Boatman and cleaner, D. Burnie.

*Provisions for visiting investigators:* 1 research room, 3 small cubicles, and the class room when not otherwise in use (the class room seats 36), give provision for about five workers.

Plans for a new wing have now matured and it is hoped to start building in February, 1937, an extension parallel to the original building giving provision for the staff and five new work rooms as well as increased laboratory space.

*Income:* Derived from subscriptions by members, subscriptions from various public bodies, donations, sale of specimens, admissions to the museum and aquarium and a maintenance grant from the Development Commission.

*Provisions for publication of results:* Summary in Annual Report and otherwise, chiefly in Journal Marine Biological Association as well as other journals.

#### **SPAIN**

##### **Laboratorio Oceanográfico de Canarias ('34)**

*History or origin:* Established on November 8, 1928. A permanent laboratory has not yet been erected but one is contemplated for the relatively near future.<sup>10</sup>

*Location:* Las Palmas, León y Castillo 264, Canary Islands.

*Organization to which attached:* Instituto Español de Oceanografía.

*Purposes and scope of activities:* For the systematic investigations of the oceanographic and biological conditions in the vicinity of the Canary Islands.

*Equipment:* At present the quarters are only temporary.

<sup>10</sup> Primeros trabajos del Laboratorio Oceanográfico de Canarias por Luis Bellón y Emma Bardán Mateu. Instituto Espan. Oceanogr. Notas y Resúmenes, ser. 2, no. 48, pp. 79, 29 figs., 1931.

*Staff:* Luis Bellón Uriarte, Lic. Nat. Sci., Director; Emma Bardán Mateu, Lic. Nat. Sci.

*Provisions for visiting investigators:* Consult the director of the Instituto Español de Oceanografía, Alcalá 31, Madrid.

*Income:* Contribution for the Government.

*Provision for publication of results:* In the publications of the Instituto Español de Oceanografía.

### **Instituto Español de Oceanografía ('34)**

*History or origin:* Established in 1914.<sup>11</sup>

*Location:* Madrid, Alcalá 31.

*Organization to which attached:* Subsecretaría de la Marina Civil, under the Ministerio de Marina.

*Purposes:* To study the physical, chemical, and biological conditions of the seas surrounding the Spanish Peninsula and apply the results obtained to the problems of the marine fisheries.

*Scope of activities:* 1. General oceanography with special reference to fisheries and also the study of the physics, marine sediments, and the dynamics of the Spanish seas.

2. Oceanographical chemistry (analysis of waters and their elements), and industrial chemistry and its practical application to fish culture and to the preservation of fishes and their products.

3. Marine biology, mainly its application to fisheries.

4. Fishery economics and technology.

*Equipment:* At the central offices in Madrid there are four laboratories, one each for oceanography, chemistry, general biology (principally of economic value), and ichthyology. There is also a department for commerce and technology of fisheries. There are five coastal laboratories, at Santander, Palma de Mallorca, Málaga, Las Palmas (Canary Islands), and Vigo. The latter has just been established and is now in process of organization. For expeditions in waters adjacent to the Spanish Peninsula and Spanish protectorate and dominion zones, the naval coast guard vessel XAUEN is used. Some boats provided with a motor are used by the laboratories.

*Staff:* Director, Professor Odón de Buen; Sub-director, Professor Rafael de Buen.

Oceanographical department: Chief, Professor Rafael de Buen. Assistant, vacant. Assistant preparator, Jaime Magaz, Lic. Nat. Sci.

Chemistry department: Chief, Professor José Cerezo. Director, Frutos A. Gila, Lic. Ch. Assistant, Olimpio Gómez Ibáñez, Lic. Ch. Assistant preparator, Antonio Rodríguez de las Heras, Lic. Ch.

Biological Department: Chief, Dr. Fernando de Buen. Director, Dr. Victoriano Rivera. Assistant, vacant. Assistant preparator, María de las Mercedes García López, Lic. Nat. Sci.

Commerce and technology of fisheries: Chief, Cap. de Navío, José María Roldán. Assistant, Jimena Quirós, Lic. Nat. Sci.

*Provisions for visiting investigators:* See the account of the coastal laboratories.

*Income:* Sources: From the budget of the State, tickets for aquarium and museum, sale of publications, renting of work rooms at the laboratories, aided by fishery organizations.

*Provisions for publication of results:* Memorias, Resultados de Campañas y Trabajos, Notas y Resúmenes, Boletín de Pesca, now Boletín de Oceanografía y Pesca.

### **Laboratorio de Málaga ('34)**

*History or origin:* Established in 1914 in conjunction with the Laboratorio de Palma de Mallorca to offer opportunity for study of the interesting oceanographic and biological conditions in the vicinity of the Strait of Gibraltar. The building is temporary. A large laboratory is to be constructed near the present site.

*Location:* Málaga, south coast, near the extreme west of the Mediterranean.

*Organization to which attached:* Instituto Español de Oceanografía.

*Purposes and scope of activities:* Marine biology and oceanography. Oceanographical conditions of the region that have been studied during various years. Many species of fish have been collected. There are now enough bottom samples to make possible the preparation and publication of a chart of the lithology of the sea bottom in the area adjacent to Málaga.

*Equipment:* Laboratories for oceanography, chemistry, and biology. A museum, a photographic room, a boat PRINCIPE ALBERTO DE MONACO, with an auxiliary motor of 35 hp., and 16 tons displacement.

*Staff:* Director, Alvaro de Miranda, Lic. Cienc. Nat.; Assistant, Angel Alconada, Lic. Cienc. Nat.

*Provisions for visiting investigators:* The laboratory

<sup>11</sup> Organización y labor efectuada por el Instituto Español de Oceanografía. Instituto Español de Oceanografía, Notas y Resúmenes, series 2, no. 62, pp. 1-122, 11 pls., November, 1932.

has been visited by many Spanish and foreign professors and students of the universities of Madrid and Granada and other centers of learning. Courses have been organized for the study of the different aspects of the sea.

*Provision for publication of results:* In the publications of the Instituto Español de Oceanografía.

#### Laboratorio de Palma de Mallorca ('34)

*History or origin:* Established in 1906 by the National Museum of Natural History.

*Location:* Palma, Island of Mallorca, Balearic Islands, in the Mediterranean.

*Organization to which attached:* Instituto Español de Oceanografía. (Since 1919.)

*Purposes and scope of activities:* To send live marine animals to the universities and other institutions of learning, to acquaint the students with the problems of marine biology, to conduct oceanographic investigations and experiments in the culture of marine animals, and to give needed help to foreign and Spanish naturalists who desire to work there. The temperature and salinity of the adjacent waters have been studied, expeditions have been made on the gun boat VASCO NUÑEZ DE BALBOA to study hydrographic conditions to the greater depths, and a chart of the bottom deposits of the bay has been published.

*Equipment:* Chemical, biological, and oceanographic laboratories; photographic rooms; store rooms for instruments, et cetera; rooms for the preparation of samples, collections, et cetera; aquarium; museum; library. Modern installations for investigations include work rooms with fresh and salt water. The laboratory has its own harbor where it keeps its vessels, all provided with motors.

*Staff:* Director, Francisco de P. Navarro, Lic. Nat. Sci.; Assistant, Miguel Massutí, Lic. Nat. Sci.

*Provisions for visiting investigators:* A large number of foreign and Spanish professors and specialists visit the laboratory. Frequent excursions are arranged for the students of the universities of Barcelona and Madrid and of foreign centers. Work rooms are rented permanently by important German scientific institutions. It is one of the best known scientific centers in Europe with regard to oceanography and biology.

*Income:* Variable (Budget of State).

*Provision for publication of results:* In the publications of the Instituto Español de Oceanografía.

#### Instituto y Observatorio de Marina de San Fernando ('34)

*History or origin:* Established in 1754.

*Location:* San Fernando (Cadiz).

*Organization to which attached:* Government institution.

*Purposes and scope of activities:* One of its three sections is concerned with marine meteorology, magnetism, nautical instruments, and tides.

*Equipment:* Important library.

*Staff:* Director, D. Leon Herrero, Contralmirante in the Navy; Subdirector, D. Wenceslao Benitez, Capitán de Navio.

*Provision for publication of results:* Almanaque Nautico, Anales Meteorológicos, Magnéticos, y Sísmicos, Catálogo Astrofotográfico zona  $-3^{\circ}$  a  $-9^{\circ}$ , Carta fotográfica del Cielo, Cartas nauticas, Derroteros, Código de señales, Avisos a los navegantes, Cuadernos de Faros.

#### Servicio Hydrográfico ('36)

*Location:* San Fernando, Cadiz.

*Organization to which attached:* 4a Section of Observatorio de Marina de San Fernando.

*Staff:* Director, Director del Observatorio, Contralmirante Hydrografo D. Leon Herrero.

Sub-Director, Subdirector del Observatorio, Capitán de Navio Hydrografo D. Wenceslao Benitez.

Head of the 4th Section of the Observatory, Capitán de Navio Hydrografo J. José Pérez.

Charts, Capitán de Corbeta D. Rafael Sanchez.

Sailing Directions, Teniente de Navio Hydrografo D. Diego Gomez.

Light lists, Capitán de Corbeta D. Rafael Sanchez.

Notices to Mariners, Capitán de Corbeta D. Rafael Sanchez.

Tides, Capitán de Corbeta Hydrografo D. Francisco Fernandez de la Puente.

Hydrographic Commission, Capitán de Fragata Hydrografo D. Federico Aznar.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
CASTOR.....	60		12
POLLUX.....	60		12
TOFINO.....	1,220	9	79
MALESPINA			

**Sociedad de Oceanografía de Guipúzcoa**  
(27, Magrini)

*Location:* San Sebastian (Rue Aldemar).

*Organization to which attached:* Private institution.

*Purposes and scope of activities:* The popularization of the problems of oceanography and fisheries. It renders valuable service in oceanographic investigations in Spain.

*Equipment:* Laboratories for oceanography and marine biology. Fisheries school. Library.

*Provision for publication of results:* Bulletin.

**Laboratorio de Santander ('34)**

*History or origin:* Through the efforts of D. Augusto González Linares, this station was established in May, 1886, under the name of Estación marítima de Zoología y Botánica experimentales. It became a part of the Instituto Español de Oceanografía when the latter was established in 1914.

*Location:* Santander, on the Gulf of Biscay.

*Organization to which attached:* Instituto Español de Oceanografía.

*Purposes and scope of activities:* The study of the flora and the fauna of the coastal regions. Formation and increase of the scientific collections of museums and institutions of learning and the application of scientific studies to the development of maritime industries. Teaching of marine zoology and botany to students of the University of Madrid and to serve as a place of research for Spanish and foreign naturalists and biologists.

*Equipment:* Aquarium, various chemical and biological laboratories, store house for oceanographic instruments and fishing gear, and a complete museum of local marine organisms, library, collections for study, various work rooms, et cetera, some boats, two of them provided with motors.

*Staff:* Director, Dr. Luís Alaejos; Assistant, Dr. Juan Cuesta.

*Provisions for visiting investigators:* Investigators both national and foreign are received, also pupils, principally for summer school.

*Income:* From the State and from the corporations of the locality.

*Provision for publication of results:* In the publications of the Instituto Español de Oceanografía.

**Laboratorio de Vigo ('34)**

*History or origin:* Established in 1934. (In process of organization.)

*Location:* Vigo.

*Organization to which attached:* Instituto Español de Oceanografía.

**SWEDEN**

**Bornö Research Station ('37)**

*History or origin:* Built in 1901 by O. Pettersson and G. Ekman, passed into state ownership in 1932.

*Location:* Half way up the Gullmar-fjord, the largest and deepest of Swedish fjords.

*Organization to which attached:* Svenska Hydrografisk-Biologiska Kommissionen.

*Purposes:* Center for carrying out the hydrographical part of the Kommissionen's program.

*Scope of activities:* Base of the hydrographic expeditions with the SKAGERAK. Running observations of internal water-movements, daily hydrographic soundings since 1909.

*Equipment:* A stock of instruments, partly of special construction, for the study of internal waves, currents, light penetration, et cetera, and an observation pier affording 34 meters depth, 2 motorboats mainly used for traffic.

*Staff:* Director, Professor Hans Pettersson (not salaried); 1st Assistant, Licentiat B. Kullenberg; 2nd Assistant, Licentiat N. Y. Gustafsson; Mechanic, A. Fries.

*Provisions for visiting investigators:* Guests are occasionally received for carrying out special investigations.

*Income:* Part of the state grant for the Kommissionen is allotted to Bornö, about 16,000 Kr.

*Provision for publication of results:* Svenska Hydrografisk-Biologiska Kommissionens Shrifter, Serie Hydrografi, also occasional publications in Meddelanden från Göteborgs Högskola Oceanografiske Institution.

**Klubbans Biological Station ('37)**

*History or origin:* Founded by Professor A. Appellöf, Uppsala, 1915.

*Location:* In the fishing village of Fiskebäckskil on the west coast of Sweden. Post address, Fiskebäckskil.

*Organization to which attached:* University of Uppsala.

*Purposes:* The principal purpose is instruction of students of the University in the marine fauna. When the finances are sufficient, independent researches are also prosecuted.

*Scope of activities:* The Swedish coastal tidal flats of the Province of Bohuslän.

*Equipment:* The usual equipment for making zoological and ichthyological collections as well as apparatus for making quantitative investigations of soft bottoms and a motor boat.

*Staff:* Director, Sven Ekman, Professor in the Zoological Museum, University of Uppsala. 2 subordinate officers.

*Provision for visiting investigators:* The Station has not yet been outfitted to care for scientific guests and it can be used only during the summer.

*Income:* Source: State appropriation.

Amount: 5,000 Swedish Kronor yearly.

*Provisions for publication of results:* None.

#### Kristinebergs Zoologiska Station ('37)

*History or origin:* Founded in 1877.

*Location:* On the west coast of Sweden, near the mouth of the Gullmarfjord, at Fiskebäckskil.

*Organization to which attached:* Royal Swedish Academy of Science.

*Purposes:* Research and some instruction.

*Scope of activities:* A course in marine zoology is given every year in June for Swedish University students.

*Equipment:* Two laboratories with modern equipment for investigations. Library with 10,000 volumes and reprints. Motor boat SVEN LOVÉN, 42 feet long, 16 foot beam, with a 30 horse-power petrol motor. 2 small motor boats. A tower for sea water, capacity 70 cu. m. Boarding house. 3 official residences.

*Staff:* Director, Professor Dr. Einar Lönnberg, Stockholm. Manager, Fil. Dr. Gunnar Gustafson, Fiskebäckskil. Maintenance and operation: 4.

*Provisions for visiting investigators:* The station is open all the year. Research material, reagents and instruments are free for use, without any cost. The visitors are permitted to stay in the boarding house and have only to pay the cost for meals. Foreign investigators are welcome and have the same privileges. There are 20 work places.

*Income:* The yearly budget is 24,500 Swedish Kronor paid by the Royal Academy of Science.

*Provision for the publication of results:* The Station has no series of its own. The result of work done at the Station is published in the publications of the Swedish Royal Academy of Science.

#### Oceanografiska Institutionen vid Göteborgs Högskola ('37)

*History or origin:* Founded as docentur—experimental grant and allotment of three rooms—by a private donor, Doctor Gustaf Ekman, in 1914. The chair in oceanography was founded in 1930 by Mr. Knut Mark, as professor.

*Location:* Göteborg, in the building of the Högskola, now comprising three rooms and lecture room.

*Organization to which attached:* Belongs to Göteborgs Högskola, a university (incomplete), founded by private donors and subsidized by the city of Göteborg.

*Purposes and scope of activities:* Teaching of students for graduate and postgraduate courses as a complement to the course in geography. Also research in oceanography and geophysics.

*Equipment:* A stock of oceanographic, physical, and chemical apparatus acquired from annual grant.

*Staff:* Scientific: Director, Dr. Hans Pettersson. A docent, at present vacant. The assistants of Svenska Hydrografisk-Biologiska Kommissionen make use of the institution for their research.

*Provisions for visiting investigators:* No provisions for regular visitors; occasionally guests have worked in the institution.

*Income:* Source: Income from donations made by Dr. Gustaf Ekman and Mr. Knut Mark.

Amount: (Of donations from which income is derived) 100,000 Kronor—Dr. Gustaf Ekman, for experimental grant (inclusive of salary for docent). 300,000 Kronor—Mr. Knut Mark, for salary to professor in oceanography.

*Provision for publication of results:* The results from the scientific investigations of the director, who is also director of hydrographical work for the Svenska Hydrografisk-Biologiska Kommissionen, with which body the institution is in close co-operation, are published in a series "Meddelanden från Oceanografiska Institutionen vid Göteborgs Högskola" included in "Kungliga Vetenskaps- och Vitterhetssamhällets Handlingar Göteborg." The series which was started in 1931 has at present 12 numbers in large 8 quartos.

*Note:* Thanks to the munificence of "Knut and Alice Wallenbergs Stiftelse," the same private donor who had provided the Svenska H. B. Kommissionen with its two Stations at Bornö and Lysekil, a new Oceanographic Institute will soon be erected in Göteborg, building operations to commence in the

autumn of 1937. The sum allotted for building and equipment is 370,000 kr. This new institute will belong to the Royal Society of Göteborg, i.e., Göteborgs Kungliga Vetenskaps- och Vitterhets Samhälle. The Oceanografiska Institutionen of Göteborgs Högskola will be housed in the institute and its chief will be the holder of the chair in oceanography. Beside the present income from Gustaf Ekman's donation, a contribution from Knut and Alice Wallenbergs foundation of 10,000 kr. annually has been granted for a period of 10 years starting from 1938. In the board of directors, the Svenska Hydrografisk-Biologiska Kommissionen will be represented through its chairman and Sjöfartsmuseet in Göteborg and representatives of Göteborgs Högskola. The new institute will thus work in close coöperation with the said institutes. Its scope of activities will be partly the same as those of Kommissionen, partly instruction. It will afford facilities for work also to a limited number of resident visitors. Publications: Medd. Oceanograf Institutet included in the Förhandlingar of Göteborgs Kungl. Vetenskaps- och Vitterhets Samhälle.

#### **Svenska Hydrografisk-Biologiska Kommissionen ('37)**

*History or origin:* Arose from Svenska Hydrografiska Kommissionen which was formed in the middle of the nineties by Otto Pettersson, Gustaf Ekman, and August Wijkander for the scientific study of the sea off the Swedish coasts. It was reconstituted about 1900 by the inclusion of members for biology of which P. T. Cleve and Filip Trybom were among the first.

*Location:* Göteborg.

*Organization to which attached:* The Kommission is under the Department of Agriculture in Stockholm, its grant coming under that department. Two members, Doctor Andersson and Prof. Nils Zeilon, are Swedish delegates to the International Council for the Exploration of the Sea. One of the purposes of the Kommission is to carry out Sweden's part of the international investigations.

*Purposes and scope of activities:* The purpose of the Kommission's work is to carry out and publish investigations, oceanographic and biologic, within the sea around the Swedish coasts and especially to carry out Sweden's part in the international investigations. Also to supervise and edit observations from lightships.

*Equipment:* The Kommission has jurisdiction over the newly built research motorship the SKAGERAK

which is fully equipped for all kinds of work in fishery and oceanography. It has two research stations, Bornö, half way up the Gullmar-fjord, built in 1901; and Havsfiskelaboratoriet at the mouth of the same fjord, built in 1929. For each of these stations, see the appropriate special statement.

*Staff:* The members of the Kommission serve gratuitously.

President of the Kommission, the Governor of Göteborg.

For Hydrography, Prof. Hans Pettersson, Göteborg; Prof. N. Zeilon, Lund.

For Fishery and Biology, Dr. K. Anderson of Lantbrukastyrelsen, Stockholm; Dr. N. Rosen. Fisheries Inspector of the Western District and Secretary Länsassessor, A. Thofelt.

*Provisions for visiting investigators:* No special provisions for visiting investigators exist although at Bornö guests are occasionally received for carrying out special investigations.

*Income:* Source: Government grant. Varies from year to year.

Amount: About 20,000 Kr., plus about 90,000 Kr. for running the ship SKAGERAK.

*Provision for publication of results:* The Svenska Hydrografisk-Biologiska Kommissionens Skrifter appear irregularly in two series, "Hydrography" and "Biology." New series in quarto. Until now, thirteen numbers of the hydrographic and five of the biologic have appeared. The lightship publications are issued annually, one volume in quarto, since 1923.

#### **Havsfiskelaboratoriet ('37)**

*History or origin:* Built in 1929.

*Location:* At the mouth of the Gullmar-fjord.

*Organization to which attached:* Svenska Hydrografisk-Biologiska Kommissionen.

*Purposes and scope of activities:* The biological (fishery and plankton) part of the Svenska H. B. Kommissionen's work and also technical chemical investigations on the preservation of fish and other problems of the fishery industry.

*Equipment:* Mainly equipped for microscopic and plankton work but has aquariums with running sea-water. The chemical technical department is equipped for chemical and biochemical work.

*Staff:* 1st Assistant, Dr. A. Molander, Fishery and biology. 2nd Assistant, Licentiat H. Höglund, plankton. Extra assistant, Fil. Kandidat G. Stordal, plankton counts.

Chemical-technical Department: Laborator, Dr. M. Lundborg; Biträde, Dr. Lucie Ahlström. For both departments: Clerk, Miss Ingrid Ekdahl; Mechanic, C. Karlsson.

*Provisions for visiting investigators:* None.

*Income:* Part of the grant allotted to Svenska Hydrografisk-Biologiska Kommissionen.

*Provisions for publication of results:* Svenska Hydrografisk-Biologiska Kommissionens Shriftr, Serie Biologi.

### Kungliga Sjökarteverket (Hydrographic Service) ('37)

*Location:* Stockholm.

*Staff:* Hydrographer, Kommendörkapten E. Bouveng.

Head of Division of Hydrography and Instruments, Kapten E. Färnström.

Head of Division of Charts, H. Odelsjö, B.A.

Head of Section of Notices to Mariners, Kommendör (Res.) A. Hägg.

Head of Section of Sailing Directions, Kommendörkapten (Res.) C. B. Erikson.

Head of Geodetic Section, S. Hilding, B.A.

Cartographer, P. Collinder, Ph.D.

Head of Section for control of compasses and ships' lights, E. O. Edelstam, M.A.

Head of Section of Magnetic Research, G. S. Ljungdahl, Ph.D.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENTS	OFFICERS	CREW
JOHAN NORDENANCKAR.....	260	5	33
PETER GEDDA.....	140	3	23
RAN.....	200	4	29
SVALAN.....	125	3	24
FALKEN.....	160	3	32
EJDERN.....	95	2	16

### TUNIS

#### Oceanographic Station of Salammbó ('34)

*History or origin:* Established in 1924.<sup>12</sup>

*Location:* Salammbó near Carthage.

*Organization to which attached:* Direction Générale des Travaux Publics.

*Purposes:* To investigate the marine organisms, especially fishes and Crustacea of economic significance, along the coast of Tunis.

*Scope of activities:* General biological investigation of edible fish and Crustacea (including fishery

<sup>12</sup> See Heldt, H., Rapport sur l'Organisation, l'Activité et les Travaux de la Station Océanographique de Salammbó depuis sa création (1924-1931), Station Océanographique de Salammbó, Bull. no. 24, November, 1931.

statistics), ecology of the intertidal and other coastal areas, faunistic studies, marine algae, physiology of marine organisms, chemistry of local waters.

*Equipment:* Museum which exhibits various marine organisms, fishing gear, and some types of boats; an aquarium; laboratories for scientific research. In the laboratory there are 3 rooms for biology, a chemical laboratory, and a special laboratory for work in physical chemistry. The different laboratories are supplied with both fresh and salt water. There are also photographic rooms. The library contains several thousand volumes (6200 in 1933) on general zoology, biology, embryology, histology, oceanography, expeditions, and fisheries.

*Staff:* Director Monsieur H. Heldt; Assistant, Mme. Heldt.

*Provision for visiting investigators:* Several visitors can be accommodated and are welcome, some assistance is given to those who come from various French educational and scientific institutions.

*Income:* From revenues derived by the State from the exploitation of fishing in Lac de Tunis. Annual budget about 500,000 francs.

*Provision for publication:* Notes, 27 published; Bulletin, 30 published; Annales, 8 published; also Tables de pH, Illustrated Catalogue of the Museum and Aquarium, and an Illustrated Guide for the Museum and Aquarium.

### TURKEY

#### Harta Genel Direktörlüğü Hidrografi Subesi (Hydrographic Section of the Cartographical Service of the Army) ('37)

*Location:* Ankara.

*Staff:* Hydrographer, Albay Ahmet Rasim Barkinay.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENTS	OFFICERS	CREW
AYDIN-REIZ.....	610	4	28

### UNION OF SOUTH AFRICA

#### Fisheries Survey Division ('37)

*History or origin:* The present Fisheries was established in the year 1920.<sup>13</sup>

*Location:* Capetown, Union of South Africa.

<sup>13</sup> Union of South Africa Fisheries and Marine Biological Survey, Report No. 1 for the year 1920 by J. D. F. Gilchrist, M.A., D.Sc., Capetown, 1921.

*Organization to which attached:* Department of Commerce and Industries.

*Purposes and scope of activities:* Research work is carried out at sea to determine the biological aspects and the distribution of the commoner types of marine fishes, crustaceans, and other marine organisms of economic significance. Oceanographical work is also carried out and the usual chemical and physical analyses are made.

*Equipment:* A specially constructed vessel, R. S. AFRICANA, with all modern equipment necessary for marine survey work; laboratory Marine Biological Station at Sea Point, Cape Town.

*Staff:* Director, Dr. C. von Bonde.

*Provisions for visiting investigators:* See statement on the laboratory at St. James.

*Income:* Governmental appropriation.

*Provisions for publication of results:* The Reports of the Fisheries and Marine Biological Survey. Investigational Reports and Fisheries Bulletins are issued from time to time.

#### **Marine Biological Station and Headquarters of the Division of Fisheries ('37)**

*(After the construction of the building mentioned below the station at St. James in False Bay will be abandoned).*

*History or origin:* Under construction at cost of \$100,000.00.

*Location:* Sea Point, near Cape Town.

*Organization to which attached:* Division of Fisheries of the Department of Commerce and Industries.

*Purposes and scope of activities:* The new buildings will house the administrative and research offices and laboratories of the Division and will replace the St. James Marine Biological Station which will be handed over to the Marine Biological Society of South Africa. Research will be conducted in connection with the Fishery Industry of South Africa in all its phases.

*Equipment:* Library with numerous catalogued reprints and text books dealing with fisheries research and marine biology. Fish Hatchery and six laboratories. Fully equipped for all aspects of marine biological research. Aquarium of modern construction with 43 tanks. This aquarium will be a public institution and will be directly controlled by the Division of Fisheries.

*Staff:* Scientific and technical: Dr. C. von Bonde, Director of Fisheries and Honorary Director of the Aquarium. Mr. J. M. Marchand, M.Sc., Technical Assistant. A further technical assist-

ant is being appointed and there will be a number of aquarium assistants under a superintendent. Maintenance: Caretakers and technicians.

*Provisions for visiting investigators:* Accommodation for ten research workers.

*Income:* Maintained for the Division of Fisheries by the Government of the Union of South Africa. The income from the Aquarium will be handed over to the Cape Town Municipality who must pay for the maintenance of the Aquarium.

*Provision for publication of results:* The Division of Fisheries publishes an annual report and also Investigational Reports and Fisheries Bulletins from time to time.

#### **Marine Biological Station of the Division of Fisheries Survey, Department of Commerce and Industries ('37)**

*History or origin:* Built in 1895.

*Location:* At St. James on False Bay, 18 miles from Cape Town. (After the construction of the new building at Sea Point, near Cape Town, the station at St. James in False Bay, will be vacated and handed over to the Marine Biological Society of South Africa.)

*Organization to which attached:* Fisheries Survey Division of the Department of Commerce and Industries.

*Purposes and scope of activities:* Research into life histories and so forth of the marine fauna of South Africa. Oceanographical researches.

*Equipment:* Library with numerous catalogued reprints and text books dealing with marine biological research. All the more important publications of various marine stations are received on exchange basis.

Laboratory capable of accommodating 6 workers. Fully equipped for most aspects of marine research.

Aquarium with 3 large tanks, 6 medium and 6 small tanks for experimental research work.

*Staff:* Scientific and technical: Dr. C. von Bonde, Director of the Fisheries and Marine Biological Survey. Mr. J. M. Marchand, M.Sc., Technical assistant to the Director. Maintenance: One caretaker and general handyman.

*Provisions for visiting investigators:* Accommodation for 4 research workers.

*Income:* Maintained for the Division of Fisheries Survey by the Government of the Union of South Africa.

*Provision for publication of results:* The Division of

Fishery Survey publishes an annual report in which papers emanating from the laboratory appear.

**Department van Verdediging (Hydrographic Survey  
Section of the South African Naval  
Service) ('37)**

*Location:* Department of Defence, Pretoria.

*Staff:* Officer in charge of Hydrographic Survey,  
Lieut.-Commr. James Dalglish, S.A.N.S.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
AFRICANA.....	313	4	19

**YUGOSLAVIA**

**Hydrografski ured Kraljevske Mornarice (Hydro-  
graphic Office of the Royal Navy),  
Kraljevina Jugoslavija ('37)**

*Location:* Split.

*Staff:* Director, Kapetan bojnog broda, August J. Kuster.

Head of Charts Department, Porucnik boj. broda  
a. kl. Anton A. Zupan.

Head of Section of Navigation, Porucnik boj.  
broda 2. kl. Predrag D. Lapcevic.

Head of Reproduction Department, Dragutin L.  
Poljanec.

Head of Meteorological Section, Mihajlo P.  
Spasov.

**Oceanografski Institut Kraljevine Jugoslavije  
(Oceanographic Institution of the Kingdom  
of Yugoslavia) ('37)**

*History or origin:* After the Great War and the creation of the new State of Yugoslavia, upon the proposal of the Yugoslavian Academy of Sciences and Arts at Zagreb in 1919 to the Royal Serbian Academy of Belgrade, there was constituted within the two academies a committee which had for its purpose the establishment of an institute of marine biology. In compliance with the desires of the academies, the State has made during a series of years in its annual budgets an important appropriation intended for the construction of the institution. In the year 1930 a provisional station was established in rented quarters, but during the past year 1933, the first building intended to lodge the officers of the institution was erected. Leaving the rented quarters, the station has provisionally occupied

the ground floor of the newly erected building where it is now installed. At the same time, work was begun on the large building which will also contain an aquarium and of which the roof is already in place. The interior work on the building will soon be undertaken and it is expected that it will be entirely complete within three years.

*Location:* Split, Yugoslavia, the center of the east coast of the Adriatic on the tip of the Marjan Peninsula, 5 kilometers from the center of the city of Split.

*Organization to which attached:* The Yugoslavian Academy of Sciences and Arts at Zagreb and the Royal Serbian Academy of Sciences at Belgrade, under the jurisdiction of the Ministry of Public Instruction. The trustees are as follows:

Dr. Živojin Cjorgjević, professor of zoology at the University of Belgrade, President.

Dr. V. Vouk, professor of botany at the University of Zagreb, member of the Executive Committee.

Other members of the Committee:

Dr. A. Gavazzi, professor of geography at the University of Zagreb.

Dr. J. Gjaša, professor of physiology at the University of Belgrade.

Dr. J. Hadži, professor of zoology at the University of Ljubljana.

Dr. B. Zarnik, professor of biology at the University of Zagreb.

*Purposes and scope of activities:* The institution is divided into three sections: (1) biology, (2) hydrography, and (3) applied biology (fisheries). Biological and hydrological researches especially along the Yugoslavian coast of the Adriatic. Giving expert advice concerning the exploitation of the sea. Organization of courses in marine biology for university students. Provisions for scientific work on the sea and supplying research material for investigators and for the laboratories of the University.

*Equipment:* The station now has at its disposition 10 rooms, laboratories for the officers, laboratory for personal research, hydrographic laboratory, experimental aquarium. The large building will contain an aquarium, 2 large rooms for instruction, 8 rooms intended for personal research, different sections such as applied biology (fisheries), biology, botany, chemistry, physiology, and hydrographic sections and finally the library. The station has the necessary apparatus for

marine biology and hydrographic work, as well as the motor boat Bros and 2 skiffs.

*Staff:* Director, Dr. V. Vouk, professor at the University of Zagreb, algae. Assistant director, Dr. A. Ercebović, algae, phytoplankton, hydrography. Mr. T. Gamulin, zoology, Copepoda. Dr. A. Kotthaus, zoology, fisheries. Operation and Maintenance: 4.

*Provisions for visiting investigators:* In addition to the staff, five or six work places. The large institution will have about 20 work places.

*Income:* Regular annual appropriation from the State, about 100,000 Dinars.

*Provision for the publication of results:* "Acta Adriatica." (Issued 9 vol. at present.)

## U.S.S.R., WESTERN PART

### **The Azerbaidjan Fisheries Station (formerly the Baku Ichthyological Laboratory) ('34)**

*History or origin:* Founded in 1913 by the former Department of Agriculture.

*Location:* Baku, Street of the 28th April, No. 8.

*Organization to which attached:* All-Union Scientific Research Institute of Marine Fisheries and Oceanography in Moscow.

*Purposes:* Investigation of food fishes, hydrobiology, hydrology, technique of fishing and curing and manufacture of fish products, pisciculture, and melioration of rivers and lakes for the fishery.

*Scope of activities:* The Azerbaidjan fisheries region, extending along the southwestern coast of the Caspian Sea from the Samura river to the Persian boundary. They likewise include the principal river systems, chiefly the river Kura.

*Equipment:* Its own premises will be completed by the middle of 1934. The work of the station is divided into four sections, ichthyological, pisciculture and melioration (with a small hydrochemical laboratory), fishing technique (a special laboratory is being organized for testing net fabrics and net preservation), handling fish and manufacture of fish products with a technological and chemical laboratory. A special oceanographic station with hydrological, hydrochemical, and hydrobiological laboratories is being organized in the current year,—1934. Hitherto corresponding research work had been conducted by the Ichthyological Section. Two research vessels, the motor ship DELPHIN, and the motor boat, KNIRM. Investigations are likewise conducted on board ships of the fishing fleet. The station is well supplied with apparatus. A special scientific library of about 12,000 volumes.

*Staff:* Director of the Institution: M. K. Gerassimov.

Ichthyologists: V. N. Beliaiev, chief; L. V. Arnoldi, M. P. Borsenko, G. N. Goldentracht, K. F. Voevodko.

Specialist in Pisciculture and melioration: A. N. Derjavin.

Specialist in fish handling and manufacturing: S. P. Levanidov.

Specialist in fishing technique: S. S. Sanov.

22 Assistants: Shah Abdoulaiev, Mrs. E. R. Fortunatova, A. Makhmoudbekov, J. S. Ginsburg, A. S. Mamedov, T. T. Liagunov, Mrs. M. S. MaiBorodina, A. Gadjibababekov, Miss E. N. Kudelina, Miss E. B. Kulikova, N. J. Babuskin, N. J. Belousov, N. G. Afanassiev, A. L. Amirdjanov, G. A. Tunikov, Miss M. S. Fedorova, Miss A. S. Cinkova, T. S. Malian, T. Djavadian, Miss L. Degtiarieva, Miss S. I. Peissakhova, A. A. Nadiradze.

Technical and administrative personnel: 74 persons.

*Provision for visiting investigators:* No special accommodations, but the station rarely refuses place and instruments to persons desiring temporarily to conduct investigations at the station.

*Income:* Sources, State Budget and money received from industrial organizations for contracts concluded by the station for investigations of special scientific questions. The budget for 1934 is estimated at Rbls 463,000.

*Provisions for publication of results:* The following publications have appeared: "Reports of the Baku Ichthyological Laboratory," vol. 1, 2 (issues 1, 2); "Journal of the Azerbaidjan Scientific Station of Fisheries," vol. 3, issues 1, 2, 3. Papers of members of the station have likewise been published in other publications, as Bulletin of the Caspian Scientific Fisheries Expedition (Baku 1932-33), in all 6 issues; Economic News of Azerbaidjan; Journal of USSR Fisheries and others. Over 800 pages are ready for print to be published in 1934.

### **Fisheries Station of Georgia ('34)**

*History or origin:* Founded in July, 1931, by the People's Commissariat of Supplies of the Soviet Socialist Republic of Georgia.

*Location:* Batoum (Autonomous Soviet Socialist Republic of Adjaristan), on the shore of the Black Sea.

*Organization to which attached:* Affiliated with the All-Union Scientific Research Institute of Marine Fisheries and Oceanography in Moscow.

*Purposes:* The chief object of the station is the

general study of the biology of the marine and fresh-water areas of Georgia and of the neighboring regions to reveal their natural resources. The principal objects in respect of marine areas are the study of the distribution, amount, and migrations of food fishes and useful animals, study of the productivity of the sea and of the balance of organic matter, investigations by field observations and laboratory experiments of the relations between environment and living organisms, general oceanographic survey of the southeastern part of the Black Sea, study and application of new fishing gear and the improvement and mechanization of existing fishing technique, investigation of new food fishes and animals.

Concerning the fresh-water areas of Georgia the principal objects of investigation are the study of rivers and lakes suitable for the fish industry and their melioration and rational exploitation, the investigation of questions of pisciculture and the study of the utilization of various hydrotechnical constructions for pisciculture.

*Scope of activities:* The whole territory of SSR of Georgia and the southeast part of the Black Sea.

*Equipment:* The station is at present in temporary premises, but it is building a special building on the shore of the Black Sea, which will have 20 special rooms for laboratories, aquarium, library, museum, etc. A sail- and motor-research schooner ABKHAZETZ of 50 tons, equipped for oceanographic survey work. No adequate equipment in apparatus and instruments as yet.

*Staff:* Director, S. M. Maliatski.

Hydrobiologists: Prof. V. N. Nikitin, chief; Miss N. S. Tchohuri.

Hydrologist: S. S. Liatti.

Ichthyologists: V. G. Marti, Miss A. A. Maiorova.

Specialist in marine mammals: S. E. Kleinenberg.

Specialist in pisciculture: L. A. Kutchin.

Specialist in fishing technique: N. N. Danilevski.

Economist: K. P. Gabounia.

Technical staff—27 persons.

*Provision for visiting investigators:* There will be places in the new building for visitors.

*Income:* The station is financed by the State Budget and by contracts with industrial organizations. The Budget of the Station amounted in 1933 to Rbls. 221,211 (exclusive of building fund).

*Provision for publication of results:* The first volume of the Memoirs of the Biological Station of Georgia is to appear in the first part of 1934.

### Manguistau Branch of the Uralo-Caspian Scientific Fisheries Station ('34)

*History or origin:* Founded September 10, 1933, when Andrianov, director of the Chief Fisheries Department, visited the Manguistau district in connection with the organization there of the "Caspian Fish and Seal Trust," for the exploitation of the marine resources of this part of the Caspian Sea.

*Location:* The town Fort-Alexandrovsky (Post-office, village Bautino), situated on the north point of the promontory that separates the Tiub-Karagansky bay from the sea.

*Organization to which attached:* Through the Uralo-Caspian Fisheries Station affiliated with the Scientific Institute of Fisheries and Oceanography.

*Purposes:* (1) Biology of fishes and marine animals of these waters. (Migration routes of the fishes, character of the migrations, degree and period of shoaling; fish-feeding areas and productivity, character of food; collection of statistical data of fish landings, according to varieties and age; rate of growth; breeding capacities; investigations of the method for determining the age of the Caspian seal; study of the theory of calculating the number of fishes in the stock.)

(2) Hydrology (hydrological regime of the marine industrial zone and its influence on the biology of the fishes and on the fishing industries).

(3) Fish industry (technique and organization of up-to-date fishing industries; strength and size of the fishing gear, fishing fleet and their suitability for this district; the study of the necessary measures for the development of the technical side of the industries; the economic profitableness of the fishing gear employed in the district; technical indices for the different gear used, e.g., quantity of labor, size of catch; duration of fishing season; organization of collective farms, "kolhoz," in the district; technical education of personnel.

*Scope of activities:* From cape Buruntchuk (Busatchi peninsula) to cape Sue.

*Equipment:* A rented house for the station and 7 apartments for the staff. A set of hydrological and meteorological instruments. Considerable scientific equipment is expected this year. The Chief Fisheries Department is allotting this summer a marine motor drifter for research work.

*Staff:* Director, A. N. Roganov (specialist in marine mammals). Economist, M. F. Kossov. Assistants, B. I. Badamshin, F. A. Aliev. Technical staff: 8 persons. The scientific staff is to be

increased in summer 1934 by one assistant in ichthyology.

*Provisions for visiting investigators:* No places.

*Income:* Source, contracts with industrial organizations, "Fish Industry Trust," and State Budget. From the Fish Industry Trust, Rbbs. 50,000, State Budget, Rbbs. 16,500. Building Fund, Rbbs. 7,000.

*Provision for publication of results:* Two papers are being prepared, (a) a description of the present state of the fishing industries of the Manguiatau district, (b) the seal industries of the Caspian Sea; but in view of the recent organization of this branch it has as yet no publications.

#### **The Uralo-Caspian Fisheries Station ('34)**

*History or origin:* Founded in August, 1931, by the Central Scientific Institution of Fishery Investigations, Moscow, on the initiative of the head local organizations of Kazakstan.

*Location:* In the town Gouriev of West-Kazakstan Province, on the Ural River 20 kilometers from the Caspian Sea.

*Organization to which attached:* The All-Union Scientific Research Institute of Marine Fisheries and Oceanography of the Chief Fisheries Department of the USSR People's Commissariat of Supplies.

*Purposes:* Survey of the natural resources of the Uralo-Caspian fish industry region with the object of their rational exploitation and propagation.

*Scope of activities:* The eastern part of the North Caspian Sea, namely, the whole coast from the straight line passing through the village Ganiushkino on the Manguiatau River as its west boundary to the boundaries of Turkmenistan in the east. Besides the sea this station also studies the rivers Denguiza, Ural, and Emba, Lake Tcherkal, and two large series of lakes, the Kamysh-Samarskaja and Kzilkuginskaia.

*Equipment:* Premises of 400 sq. meters. A special hydrochemical laboratory, 2 wooden motor research fishing boats. The scientific equipment amounts to Rbbs. 28,500.

*Staff:* Director, K. P. Mulikovski.

Ichthyologists: Golovanov, Koshevnikov, Razgonov, Nikitina, Saenkova.

Assistants: Kargina, Doroshkov, Aidanaliev, Manessy.

Specialists in pisciculture: Diakonov, Gurieva.

Specialists in economic: Miroshkin, Rutz, Kossov.

Specialists in hydrotechnique: Shehelkov.

The total allotted scientific staff is 26, but the actual number is 16.

Auxiliary technical staff: 21 persons.

*Provision for visiting investigators:* No special places, but college students are always accommodated in the vacant places.

*Income:* From the State Budget, Rbbs. 2500; Rbbs. 255,000 was received from the Uralo-Caspian State Fish Industry Trust in accordance with contracts. Income from the realization of the fish catch from experimental fishing. The total yearly budget in 1933 amounted to Rbbs. 273,000, excluding Rbbs. 20,000 for the acquisition of scientific and other equipment and Rbbs. 20,000 fund for building and ship-repairing.

*Provision for publication of results:* No publications planned in 1933, as that year was exclusively allotted to the collection of scientific materials.

#### **Asov-Black Sea Scientific Research Institute ('34)**

*History or origin:* Founded in 1933 by the order of the People's Commissariat of Supplies of U. S. S. R. (reorganization of the Asov-Black Sea Fisheries Station founded in 1920).

*Location:* Kertch, Oulitza Pervoi Domni, No. 24, on the Kertch Bay in the Kertch Straits.

*Organization to which attached:* All-Union Scientific Research Institute of Marine Fisheries and Oceanography in Moscow,—the Chief Fisheries Department of the Commissariat of Supplies.

*Purposes:* Scientific investigations of fisheries and oceanography.

*Scope of activities:* Asov-Sea and the Black Sea.

*Equipment:* Hydrochemical, hydrobiological, ichthyological laboratories, two research vessels, a sail and motor schooner and a motor launch; microscopes, cathometers, thermometers, apparatus for determining currents, chemical apparatus, special fishing gear, and special field hydrobiological equipment.

*Staff:* Director, V. N. Tikhonov.

Chief hydrologist, A. V. Elkinbard.

Chief hydrobiologist, V. L. Pauly.

Hydrobiologist, V. P. Vorobiev.

5 assistant ichthyologists: V. V. Abramov, N. V. Lebediev, V. N. Maiski, A. N. Smirnov, R. Kostutchenko.

3 assistant hydrobiologists: Miss Dolgopolskaia, Miss L. S. Vorobieva, S. N. Stark.

Chief specialist of fishing technique, A. V. Barshev.

Specialist of fishing technique, V. P. Freiberg.

Specialist of fishing technique and fishing gear, P. K. Gudimovitch.

Specialist of mechanization of fishing, N. G. Borissov.

2 economists, S. T. Mudzalevski, A. S. Petaiev.

Assistant economist, Miss V. S. Rojanskaia.

Technical staff—13 persons.

*Provisions for visiting investigators:* No place.

*Income:* Funds supplied by commercial fisheries organizations according to special contracts. Budget in 1933 amounted to Rbls. 315,000.

*Provision for publication of results:* "Memoirs" (Trudy) of the Asov-Black Sea Fisheries Station. Ten issues of about 1000 pages. First two were published in Kertch, the rest in Rostov-on-the-Don.

#### **The Turkmenistan Fisheries Station ('34)**

*History or origin:* Founded in 1929 by act of Soviet of People's Commissars of the Turkmen Soviet Socialist Republic.

*Location:* Is situated on the east coast of the Caspian Sea in the northern part of Krasnovodsk Bay in the Muraviev Gulf in the western suburbs of the town Krasnovodsk on the sea shore.

*Organization to which attached:* Affiliated with the All-Union Scientific Research Institute of Marine Fisheries and Oceanography in Moscow.

*Purposes:* Study of the biology of food fishes and other marine useful animals; control of the effects of the fishing industries on fish and sea animals; study of the natural resources of the areas exploited; fish shoals in different seasons of the year; study of existing fishing gear and investigation for devising new gear. The principal objects of investigation are the Caspian herring, Caspian sardines, sea-perch, sea-roach, and crayfishes. The chief gear studied—active fishing gear, drift nets, purse nets, ring-nets, and allomans (turkmen-nets).

*Scope of activities:* The southeastern part of the Caspian Sea, from Cape Beg Tash in the north to the Persian boundary in the south (exclusively territorial waters of the TSSR).

*Equipment:* Its own house of 4 rooms; a separate building for technical and chemical laboratories, a small museum (now being enlarged); a store-house; 2 living houses with lodgings for scientific staff (9 one-room and 3 two-room lodgings); a research motor sailing vessel *SOKOL* of 60 tons, chiefly used as a drifter, but can also be used for trawling. Set of fishing gear, zoological and

hydrobiological instruments, set of cathometers, thermometers, etc., for ordinary hydrobiological investigations, microscopes, binoculars, apparatus for weighing and measuring. Special library of 2,200 volumes, but with an almost complete lack of foreign editions.

*Staff:* Director, V. I. Meissner (ichthyologist).

Ichthyologists: Miss E. V. Pojaluieva, Miss A. A. Michailovskaia, Miss A. Karatchevskaia, Miss Z. P. Tereschtenko.

Specialist in economics of fisheries: A. F. Nevraiev.

Assistants: B. V. Bukharin, B. I. Prikhodko.

Administrative and technical staff: 19 persons.

*Provision for visiting investigators:* Two persons can be accommodated. Students are taken in for field work (at shore observing stations and on board the boat, not more than four students at a time).

*Income:* The station is financed by the State Budget and by contracts concluded with industrial organizations (The Turkmen Fisheries Trust). The sale of the fish catch also brings in a certain income. The year's budget in 1933 amounted to Rbls. 110,000, for 1934 it is estimated at Rbls. 167,000.

*Provisions for publication of results:* As yet only the first volume (170 pages) of the "Memoirs of the Turkmen Scientific Institution of Fisheries" has appeared. Four or 5 issues (about 300 pages) of the second volume are to be published in 1934. Separate papers of the station have been published in the Bulletins of the Central Asiatic University (Tashkent) and in the Bulletin of the Caspian Expedition (Baku).

#### **Gidrograficheskij Otdel (Hydrographic Department) ('37)**

*Location:* Rochal Quay, 2, Leningrad.

*Staff:* Head of the Department, Inzhener flagman 3 ranga, V. V. Vasiljev.

Assistant-Head of Department, Inzhener flagman 3 ranga, N. J. Gorbunov.

Head of Cartographic Section, Inzhener flagman 3 ranga, P. V. Messer.

Head of Instruments Section, Voennyj inzhener 1 ranga K. S. Ukhov.

Head of Buoyage Section, Voennyj inzhener 2 ranga P. A. Krasilnikov.

Head of Hydro-meteorological Section, Voennyj inzhener 1 ranga L. V. Kudovic.

Head of Planning Section, Voennyj inzhener 1 ranga A. A. Vasiljev.

Head of Distribution Section, Voennyj inzhener 1  
ranga, A. N. Rozhdestvenskij.

Head of Compass Section, N. S. Rezvjakov.

Head of the Section of Navigation, K. S. Uchov

#### *Equipment:*

SURVEYING VESSELS	DISPLACEMENT
ASTRONOM.....	1,050
BAZIS.....	220
BAKAN.....	75
HORIZONT.....	420
POLJUS.....	110
BEGGLICKIJ.....	452
TAJMYR.....	1,330
PELENG.....	50
PRIMORJE.....	2,200
CHUKEHA.....	4,500
SEXSTAN.....	1,490
MGLA.....	500
MAJAK.....	1,100
MIGALKA.....	440
MENZULA.....	740
HYDROGRAPH.....	1,820
PRIBOJ.....	180
MOROZ.....	240
MOLNIJA.....	50
STVOR.....	140
SIRENA.....	350
MJATEL.....	767
AZIMUT.....	390

#### **Daguestan Fisheries Station ('34)**

*History or origin:* In 1924 the specialist S. A. Mitropolski organized a small ichthyological laboratory on the wharf of the Daguestan Fish Trust with the object of studying the fisheries of the Republic. In 1925 this merged into the Daguestan Central Scientific and Industrial Laboratory of the Daguestan Central Soviet of People's Economy as its Ichthyological Section. In 1928 the Ichthyological Laboratory of the Daguestan People's Commissariat of Agriculture was organized by the specialist N. A. Dmitriev. In 1929 these two institutions merged under the name of Daguestan Scientific Fisheries Station with N. A. Dmitriev as director. In 1933 the station was renamed "The Daguestan Branch of the Caspian Scientific Fisheries Institution," and in 1934 under the All-Union Scientific Research Institution of Marine Fisheries and Oceanography it became the Daguestan Fisheries Station.

*Location:* Makhach-Kala (formerly Petrovsk Port), Batareini pereouluk No. 1, in Daguestan Autonomous Soviet Socialist Republic (North Caucasus). The town is situated on the west coast

of the Caspian Sea and has a port. The Institution is located 250 meters from the shore in the town.

*Organization to which attached:* All-Union Scientific Research Institution of Marine Fisheries and Oceanography.

*Purposes:* Principal objects of research are the marine resources, the biology of marine fishes and other marine useful animals, the physics and chemistry of the sea.

*Scope of activities:* The Caspian Sea coast from the north boundary of the Republic (river Samur) to the south boundary (river Kuma) and 35-40 miles seaward (the limit for the research motor boat) and inland mountain rivers and fresh-water lakes (Eisenam Lake, the lower course of the rivers Terek, Sulak, and Samur).

*Equipment:* The station has its own house with two laboratories, ichthyological and hydrological, and two museum rooms. The remaining five rooms are used as living rooms by the director and scientific personnel. Two research vessels, Boat No. 2, a flat-bottomed, steel, sail and motor boat of 300 tons with 2 45-h.p. Deitz engines, and OCTIOBRENOK, a wooden sail and motor boat of the Japanese Kawasaki-type, with one 12-h.p. "Vosrojdenie" engine, for work along the coast. The scientific equipment of the station is quite satisfactory. A fully equipped hydrochemical laboratory, a library of 3345 volumes.

*Staff:* Director, A. P. Korniev.

Ichthyologists: T. S. Glebov, chief; D. A. Sanushevitch, E. M. Mankevitch.

Hydrologist: D. S. Diemin.

Economist: Miss A. S. Medvedieva.

Assistants—9 persons.

Technical staff—22 persons.

*Provisions for visiting investigators:* There are places for visitors.

*Income:* Source: State Budget and sums received by contract from fishery organizations (chiefly, the Daguestan Fishery Trust). The 1933 budget amounted to Rbls. 144,000. The 1934 budget is estimated at Rbls. 141,000.

*Provision for publication of results:* The Daguestan Ichthyological Laboratory published one issue of "Reports of the Daguestan Ichthyological Laboratory," 1930. The Daguestan Scientific Institution of Fisheries and Oceanography has no publication of its own. Its papers are published in the "Bulletins of Fisheries," "Planned Economy of Daguestan," "Russian Biological Journal,"

"Bulletin of the Pan-Caspian Fisheries Stations," etc. Over 400 pages of printed matter have appeared.

**The All-Union Scientific Research Institution of Marine Fisheries and Oceanography ('34)**

*History or origin:* Organized in October, 1933, by the fusion of two scientific institutions, the All-Union Scientific Research Institute of Marine Fisheries and the State Oceanographical Institute.

*Location:* Moscow, Piatnitskaia 33.

*Organization to which attached:* Chief Fisheries Department of the U. S. S. R. Commissariat of Supplies.

*Purposes:* Survey of the seas of U. S. S. R. in respect of the needs of national economy and, in particular, of the fishery and marine animal industries, likewise the study of the existing technique of these industries and of its rationalization.

*Scope of activities:* Barents, Karsk, Bering, Okhotsk, Japan, Black, Caspian, and Aral seas: Lakes Balkhash and Khanka.

*Equipment:* Affiliated institutions (Asterisk\* indicates a separate report).

\*The Polar Institute of Fisheries and Oceanography, Murmansk.

\*The Pacific Institute of Fisheries and Oceanography, Vladivostok.

\*The Asov-Black Sea Institute of Fisheries and Oceanography, Kertch.

The Volga-Caspian Fisheries Station, Astrakhan.

The North Area Fisheries Station, Archangelsk.

(Note: No specific information received.)

The Karelian Fisheries Station, Kandalaksha.

The Ob-Tasovsk Fisheries Station, Tobolsk.

\*The Kamchatka Fisheries Station, Petropavlovsk.

The Sakhalin Fisheries Station, Alexandrovsk (Sakhalin).

The North Caucasus Fisheries Station, Rostov on the Don.

\*The Georgian Fisheries Station, Batoum.

\*The Ukrainian Fisheries Station, Odessa.

\*The Uralo-Caspian Fisheries Station, Gouriev (a branch at Fort-Alexandrovsky).

\*The Azerbaidjan Fisheries Station, Baku.

\*The Daguestan Fisheries Station, Makhach-Kala.

\*The Turkmenistan Fisheries Station, Krasnovodsk.

The Crimea Hydrophysical Station, Katzivelli.

(Note: No specific information received.)

The Aral Marine Fisheries Station, Aralsk.

The Balkhash Fisheries Station, Balkhash Lake.

The Central Institution, located at Moscow, at present occupies temporary premises, but is erecting a special large building. It possesses the following laboratories: physical, chemical, geological, biological (plankton, benthos, bacteriology), mechanization of the industries section, economical section. All the floating craft belongs to the affiliated institutions.

*Staff:* Director, K. A. Mekhonoshin; Vice-director, M. T. Chesnokov; Scientific secretary, A. D. Starostin.

(a) Section of Physics and Chemistry of the Sea.

Director, V. V. Shuleikin, professor, correspond. member of the Academy (physics). Chemists: S. V. Bruevich, professor; B. A. Scopinzev, T. Trofimov. Hydrologists: V. A. Vasnezov, Sazev, Stockman, Lednev, Boshich, assistants.

(b) Section of Geology of the Sea. Director, M. V. Klenova. Geologists: T. T. Gorshkova, Kalianov, Batalina, assistants.

(c) Section of Biology of the Sea. Director, A. A. Shorygin. Bacteriologists: V. S. Butkevich, professor; Dianova, Voroshilova, assistants. Botanists: K. T. Meier, professor; Persidsky, Kizeeva, assistants. Plankton: A. T. Jashnov, professor; Ussachev, Bogorov, Chajanova, assistants. Benthos: V. A. Brozkaya; Briskina, Virstein, assistants.

(d) Section of Ichthyology. Director, B. S. Iljin; N. M. Knipovich, professor; G. N. Monastyrsky, E. V. Messiazeva, T. S. Rass, Samakhaev, Dmitriev, Berdichevsky, Pakhomov, Perzeva, assistants.

(e) Section of Fish-Culture. Director, A. T. Beresovsky. L. V. Piatakov, Amelina, Nasariev, Evstafiev, Kusnezova.

(f) Section of Marine Mammals. Director, S. J. Freiman. Dorofeev, Barabash, Zalkin, Klumov, Nicolsky, assistants.

(g) Section of Fisheries Technique. Director, A. A. Jaschenko. Specialists: Polonsky, Jampolsky, Uspensky, Liman, Mironov, Skvorzov, Kanin.

(h) Section of Fisheries Economics. Director, A. Shitkovsky. Economists: Ivanov, Rasikina, Konkina.

Staff of the Institution: Chief specialists, 12; Scientific staff, 113; Technical assistants, 28; Administrative personnel, 67.

*Provision for visiting investigators:* Only on the completion of the new premises will the Institution be able to accommodate visiting scientists.

*Income:* The yearly budget of the Institution totals Rbls. 1,460,300, and consists of funds allotted from the State Budget and received from various industrial organizations.

*Provision for publication of results:* The scientific papers of the Institution are published in the "Memoirs" of the All-Union Scientific Research Institution of Marine Fisheries and Oceanography.

#### **Polar Scientific Research Institute of Marine Fisheries and Oceanography ('34)**

*History or origin:* The Murman Biological Station has existed since 1930 as the Murman Branch of the State Oceanographic Institution. This last was reorganized at the close of 1930 into the independent Polar Scientific Research Institute of Marine Fisheries and Oceanography.

*Location:* Temporarily located in the building of the Marine Technicum, Murmansk.

*Organization to which attached:* All-Union Research Institution of Marine Fisheries and Oceanography.

*Purposes:* (1) Oceanographic survey of the Barents Sea: hydrology and chemistry, study of the currents and general dynamics; qualitative and quantitative distribution of the flora and fauna, ecology of marine organisms; distribution and origin of the sediments covering the sea bottom. (2) Scientific study of fish industries: study of coastal fishing, open-sea fishing, and deep-sea fishing; study of the herring industry, especially active methods of fishing. It is expected to organize two stations in the near future at Portchnikha on the East-Muram coast and in the Ura inlet of the Motovsky Bay, for experimental work on the biology and physiology of marine organisms in local waters.

*Scope of activities:* Barents Sea.

*Equipment:* Property of the Murman Biological Station has been transferred and is being used for the organization of these laboratories. Two research ships, PERSEUS, a steamship of 450 tons and 360 h.p., and the NIKOLAI KNIPOVITCH, a motor vessel of 200 h.p.

*Staff:* Director, G. I. Khlinovski. Vice-Director of the scientific branch, M. P. Somov. Chief specialists, 14; Scientific staff, 21; Technical assistants, 35; Administrative and technical personnel, 61.

(a) Section of Oceanography. Director, M. P.

Ossadchikh; Vice-director, M. P. Somov. Hydrologist: Tanzura. Geologist: Senkovitch. Biologists: Manteifel, Boldovsky.

(b) Section of Fisheries. Director, N. A. Maslov. Ichthyologists: Aleev, V. F. Schmit, Brynzev.

(c) Section of Fish-Industry. Director, J. T. Mentov. Specialists: N. P. Sherstoboev, Senenov. Economists: Kannibolotsky, Shishov.

*Provision for visiting investigators:* Ten visiting scientists can be accommodated.

*Income:* The yearly budget totals Rbls. 1,770,000 and consists of funds allotted from the State budget and received from various industrial organizations.

The foregoing statement should be supplemented by a short article that has recently appeared in Science.<sup>1</sup> It is as follows:

It is stated in *Nature* that a new biological station is being built by the Academy of Sciences of the U. S. S. R. at Murmansk on the Barents Sea. It is intended for extensive research in morphology, anatomy, embryology, physiology, biochemistry, and ecology of sea organisms.

Owing to the penetration of the warm waters of the Atlantic into the Barents Sea, the fauna of the latter is extremely rich and diverse. Of importance is the fact that at Dalnye-Zelenets Bay the water is transparent to a depth of 10 meters and that large stretches of the sea bottom are visible from the surface. The scientific workers at the station will make a detailed study of the problems of evolutionary physiology, embryology, and the relationship of the fauna with changed hydrological conditions effected by the Gulf Stream.

The Murmansk biological station will supply biological material to the various research institutes and higher educational institutions of the U. S. S. R. Superintending the building is a special commission consisting of S. A. Zernov (director of the station), L. A. Orbeli, V. I. Vernadsky and N. M. Knipovich, Professor K. M. Deryugin, of the University of Leningrad, Professor L. N. Fedorov, director of the All Union Institute of Experimental Medicine, and Professor I. M. Kreps.

The cost of building the Murmansk Station is estimated at 3½ million roubles, excluding equipment. A scientific library, the zoological, botanical, mi-

<sup>1</sup> The biological station at Barents Sea: *Science*, vol. 85, p. 536, June 4, 1937.

crobiological, and hydrochemical laboratories and the libraries of other departments will be housed in the main building of the station. An aquarium designed for scientific work will be installed on the first floor of this building, while several other aquaria, open to the public, will be erected in the basement of the building. Premises containing students' laboratories will be situated near the central building and will also be equipped with large aquaria. Special interest is attached to an open-air concrete reservoir intended to accommodate large sea animals, including seals.

The spawn of crabs will be brought from the Far East for acclimatization and breeding in the Barents Sea. A special vessel, 30 meters long, built for scientific work in the open sea, will maintain uninterrupted communications between the station and the city of Murmansk.

At the beginning of this year, the Academy of Sciences of the U. S. S. R. commenced extensive work in the Dalnye-Zelenets Bay, east of the Kola Bay (Teriberka district, situated in the Northern Province), for the construction of this biological station, which will be the finest in the Soviet Union. The Soviet architect N. V. Ryumin and his assistants have designed all the buildings.

#### **Novorossiisk Arnoldi Biological Station ('34)**

*History or origin:* Founded in 1921 by the Scientific Research Institution of the Kuban-Black Sea Region, dedicated to the late Prof. V. M. Arnoldi.

*Location:* In Novorossiisk on the west coast of Tsemess Bay, 200-250 meters from the shore. Address: Novorossiisk, Stanitchka, Sleptovskaia I.

*Organization to which attached:* Science Branch of the Department of Universities and Scientific Research Institutions of the People's Commissariat of Education of R. S. F. S. R.

*Purposes:* The principal objects of the Black Sea: investigation of practical problems, e.g., encrustations on submarine constructions by algae and mollusks; marine sanitation questions; study of the fisheries.

*Scope of activities:* Activities embrace the northeast part of the Black Sea, the Kertch Straits, and the district from Anape to Adler.

*Equipment:* A building of 257 sq. meters, of which 136 sq. meters are occupied by laboratories and research rooms. A biological laboratory with zoological and algological sections. Hydrochemical and bacteriological laboratories. The labora-

tories are well equipped with instruments and apparatus. The library has over 4,000 volumes of special literature. Two small sail and motor research boats.

*Staff:* Director, V. A. Vodianitski (zoologist).

Vice-director, E. A. Poteriaiev (hydrochemist).

Chief zoologist, S. G. Krishanovski.

Hydrologist, S. P. Rotar.

Hydrochemist, E. L. Rabushkin.

Botanist, Miss S. N. Mikhailovskaya.

Zoologist, Miss E. G. Kossiakina.

Zoologist, Miss S. M. Pchelina.

Technical staff—6 persons.

*Provisions for visiting investigators:* In the summer time, one or two places can be temporarily allotted for visiting investigators.

*Income:* The Station exists on the Budget of the People's Commissariat of Education. It also receives small sums from contracts for special research work. The budget in 1933 was 66,200 Rbls., including 8,000 Rbls. for scientific equipment.

*Provision for the publication of results:* The Station publishes its "Memoirs" (Trudy). Five issues have appeared, 50-180 pages each.

#### **Ukrainian Odessa Fisheries Station ('34)**

*History or origin:* Founded in 1921 by the Ukrainian People's Commissariat of Supplies.

*Location:* Odessa, Kolodesni pereculok No. 9.

*Organization to which attached:* Branch of the Asov-Black Sea Scientific Research Institute of Fisheries and Oceanography, affiliated with the All-Union Scientific Research Institute of Marine Fisheries and Oceanography in Moscow.

*Purposes:* Survey of the natural resources of the Black Sea and the reconstruction of the fishing technique. The work of the Station is divided into 4 sections: Ichthyological; Physics and chemistry of the sea; Hydrobiology; Fishing technique.

*Scope of activities:* The U. S. S. R. part of the Black Sea, chiefly the northwest part, from the Crimea to the Roumanian boundary.

*Equipment:* The Station does not possess its own buildings. It has ichthyological, hydrobiological, hydrological laboratories, and a research vessel TELMAN of 18 reg. tons.

*Staff:* Director, S. J. Sirovatsky (ichthyologist).

Assistant, Mrs. N. I. Sirovatskaia (ichthyologist).

Specialist of fishing technique, N. N. Vinogradov.

Ichthyologist, F. F. Egerman.

Ichthyologists, V. D. Kuvshinnikov, E. D. Velikokhatko. .

3 assistant ichthyologists, A. S. Stoianov, Miss E. A. Nevinskaia, I. I. Ivanov.

Chief hydrobiologist, A. K. Makarov.

Hydrobiologist, N. A. Zagorovski; assistant, A. M. Borisenko.

Assistant hydrochemists, Miss L. G. Vutte, S. E. Kaliberdin.

Assistant biologist, Miss N. E. Piliavskaia.

*Provision for visiting investigators:* Visiting scientists, post-graduate students, and students are admitted to the scientific studies of the Station.

*Income:* In 1933 the budget was Rbbs. 153,000, whereof Rbbs. 105,000 was received from Fishing Industries Trusts, according to contracts concluded. The remaining Rbbs. 48,000 was the surplus left over from the 1932 budget received from the Chief Fisheries Department (Glavryba).

*Provision for publication of results:* The Ukrainian Branch has published 24 bulletins and 6 volumes of its "Memoirs" (Trudy).

#### Sevastopol Biological Station ('34)

*History or origin:* Founded in 1872 by the Novorossiisk Society for Natural Sciences.

*Location:* Sevastopol, Primorski boulevard, Sevastopol Bay, on the seashore.

*Organization to which attached:* Academy of Sciences of the USSR.

*Purposes:* Oceanographical and hydrobiological observations, study of the fauna and flora of the Black and Asov Seas.

*Scope of activities:* Black and Asov Seas.

*Equipment:* Building, 6,000 cub. meters. Biological, chemical, and microbiological laboratories. Museum. Aquarium. Scientific library of 20,000 volumes (hydrobiology and oceanography). 20-ton research vessel. Hydrological, hydrobiological, and optical apparatus.

*Staff:* Director, S. A. Zernov (member of the Academy).

Vice Director, V. A. Vodianitsky (chief zoologist).

Chief hydrologist, N. I. Tchigirin.

Zoologist, M. A. Galadjiev.

Zoologist, L. I. Jakubova.

Botanist, N. V. Morosova-Vodianitskaia.

Microbiologist, P. I. Kopp.

Chemist, Miss N. A. Dobrjanskaia.

Technical personnel—19 persons.

*Provisions for visiting investigators:* 15 places for visiting investigators.

*Income:* State budget, 90,000 rubles in 1933; special funds, 45,000 rubles.

*Provision for the publication of results:* 13 issues in coöperation with the special Zoological Laboratory of the Academy of Science and 3 volumes of 160–200 pages of the Memoirs (Trudy) of the Sevastopol Biological Station.

# INSTITUTIONS, WEST SIDE OF THE ATLANTIC OCEAN

## BRITISH DOMINIONS

### BERMUDA

#### **Bermuda Biological Station for Research ('37)**

*History or origin:*<sup>1</sup> Originally established in 1903, with Professor E. L. Mark of Harvard as director, at Flatts in connection with a contemplated public aquarium by agreement between Harvard University, New York University, and the Bermuda Natural History Society. In 1907 Agar's Island was leased by the Bermuda Natural History Society and a public aquarium was established in association with the station under the direction of Professor Mark. From 1907 to 1918 there were regular summer sessions. Dr. W. J. Crozier was resident naturalist from 1915 to 1918. In 1917 to 1918 Agar's Island was requisitioned for military purposes and the station was transferred to Dyer's Island but was afterward retransferred. In 1926 the station was incorporated under the laws of the State of New York. The Biological Station Act of 1927 passed by the Government of Bermuda granted the Corporation (1) the privilege of holding real estate in the Islands, (2) the conveyance of the "Hunter property" to the Trustee when £50,000 endowment had been raised, (3) exemption from customs duty on all supplies and equipment of the Station, (4) an annual grant of £200 for a period of ten years. In 1929 the Rockefeller Foundation appropriated £50,000 to meet the conditions imposed by the Biological Station Act. In 1930 the Hunter property was reconveyed to the Bermuda Government and its purchase

<sup>1</sup> Bermuda Biological Station for Research, Incorporated 1926, Announcement, Thirty-first Year—1933.

The Bermuda Biological Station for Research, Incorporated 1926, Reports of Officers for the Years 1926 to 1932, 1933.

Conklin, E. G., The New Bermuda Biological Station for Research, Incorporated 1926, Announcement of the First Session at "Shore Hills," St. George's West, Bermuda, June 15 to August 10, 1931 (Twenty-ninth year of the original Bermuda Biological Station.)

Conklin, E. G., The Bermuda Biological Station for Research, Inc., Report of the President for the Year 1936. Manuscript dated December 26, 1936.

price was transferred toward the conversion of Shore Hills into a biological station. In 1931 the Shore Hills property was purchased and the conversion of it into a biological station was begun. In 1932 the station was officially opened by His Excellency, the Governor of Bermuda.

In 1936 a proposal was made for coöperative work on the Gulf Stream System by the Woods Hole Oceanographic Institution and the Bermuda Biological Station, on condition of adequate support of this work being secured on the part of the Bermuda Station. An appeal was made to the British friends of the Station, and as a result of their activity a Bermuda Oceanographic Committee, consisting of twelve leading oceanographers and biologists of Britain, was organized by the Royal Society of London. This Committee approved the plan and recommended to the British Development Commission a grant of £5,100 for the construction and equipment of an oceanographic research boat and £3,500 annually for the scientific and technical support of the Bermuda Station's part of this work. This recommendation has now been approved by the Development Commission; the project has been endorsed by the Trustees and Corporation of the Bermuda Biological Station; Columbus Iselin, of the Woods Hole Oceanographic Institution, has been elected President of the Bermuda Station. This significant international coöperation in the study of the Gulf Stream System will be put into operation as rapidly as possible.

*Location:* On a property known as Shore Hills on Ferry Reach, St. George's West, Bermuda. Dr. J. F. G. Wheeler of the "Discovery" Office, London, was installed as Director.

*Organization to which attached:* An independent organization under the control of an International Board of Trustees on which are represented England, Scotland, Canada, Bermuda, and the United States.

*Purpose and scope of activities:* To offer facilities for research in biology and in oceanography in the region of the Bermuda Islands.

*Equipment:* The Shore Hills property consists of more than 14 acres of land fronting on Ferry Reach, a main building of stone and concrete which is used as laboratory and residence, 5 cottages, boat and bathing houses, engine house, wharf, etc., all completely furnished. The buildings have been repaired and remodeled for the uses of the station.

The general laboratory accommodates 12 workers and there are several small private laboratories. There is a chemistry laboratory and in the basement of the building there have been installed a physiological laboratory with accommodations for 5 or 6 workers, an aquarium room, a dark room, a cold room, and a chemistry store room. Where needed, there are fresh water, running sea water, electricity (110 volts A.C.), and gas (Philgas).

On the sea water well beside the station jetty, there is an automatic tide recording machine of the United States Coast and Geodetic Survey. The station possesses a 24 foot launch and a small dory. Also the usual apparatus for collection. A larger boat will be acquired in the near future.

In the library there are standard works on biology, zoology, and marine research, series of contributions from various laboratories and universities, and a good collection of reprints.

*Staff:* Director, J. F. G. Wheeler, D.Sc.; 1 Secretary and librarian; 3 for maintenance and operation.

*Provisions for visiting investigators:* Although visiting investigators may be received without charge, many colleges, universities, and institutions are contributing to the upkeep of the Station by subscribing for the support of a table or research room, such subscription entitling them to the use of all the general facilities of the Station by an approved investigator or research student.

Regular fees for research rooms and tables are as follows: For one year, \$400.00; for three months, \$100.00; for two weeks or less, \$25.00.

The Station is prepared to accommodate approved investigators and research students at an inclusive fee of \$15.00 per week when there are more than six persons in residence; \$16.00 per week otherwise.

Applications for laboratory and living accommodation must be made on the official form to the director at the Station, Dr. J. F. G. Wheeler, St. George's, Bermuda, some time before the applicant purposes to take up residence.

*Income:* From fees, investments, and contributions.  
*Provision for the publication of results:* None.

#### CANADA

#### Canadian Hydrographic Service, Department of Marine ('37)

*Location:* Ottawa.

*Staff:* Hydrographer, Captain Frederick Anderson; Assistant-Director, R. J. Fraser.

Division of Hydrography: Atlantic Coast and Great Lakes District,—vacant; Pacific Coast District, Engineer-in-charge, H. D. Parizeau; Chart Construction Division, Chief of Division, G. L. Crichton; Chart Distribution Division, Engineer-in-charge, P. E. Parent.

Division of Tides and Currents: Atlantic Coast, Engineer-in-charge, H. W. Jones; Pacific Coast, Engineer-in-charge, S. C. Hayden.

Division of Precise Water Levels: Engineer-in-charge, C. A. Price.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
ACADIA.....	1,067	11	35
CARTIER.....	864	9	31
LILLOOET.....	772	9	32
W. J. STEWART.....	1,525	13	51

#### Atlantic Biological Station ('37)

*History or origin:* At first (1899) a small movable laboratory, located successively at St. Andrews, N. B., Canso, N. S., Malpeque, P. E. I., Gaspé, Que., and Seven Islands (now Clarke City), Que. Established by the Government of Canada under a scientific board for the purpose of providing facilities for Canadian scientists to investigate marine problems with a view to the ultimate benefit of the fisheries. After trial of the localities mentioned and after examination of other portions of the Canadian Atlantic Coast, a permanent site was chosen near the first place mentioned.

*Location:* On the shore of the deep (30 meters) tidal estuary of the St. Croix river, two miles north of the town of St. Andrews, province of New Brunswick. Though far inland, the successive bodies of water leading to the open Atlantic being (1) St. Croix river, (2) Passamaquoddy Bay, (3) Bay of Fundy, and (4) Gulf of Maine, the water has a salinity of over 30‰ and provides suitable conditions for a variety of open water forms such as cod, haddock, halibut, herring, and rosefish (*Sebastes*), this owing to the heavy tides. The bodies of water are graded in

size, present quite varied conditions, and, being largely enclosed, can be investigated in practically all weathers.

*Organization to which attached:* Biological Board of Canada.

*Purposes:* The provision of facilities for fundamental investigation of the problems presented by both fresh and salt water. The investigation of the waters in and near the eastern part of Canada, in particular, of the so-called Maritime provinces, Nova Scotia, New Brunswick, and Prince Edward Island, with a view to providing a proper basis for the conduct of the fisheries.

*Scope of activities:* Physical and chemical investigations of the sea and other waters; general biological investigations; special fishery investigations.

*Equipment:* Laboratories, etc.—Main laboratory, destroyed by fire in 1932, being rebuilt as fire-proof structure for year round use; part for offices, individual and general laboratories accommodating 16 investigators, storerooms, and experimental aquaria, tanks and constant temperature units, erected in 1932. Fish-handling building, with freezing and cold storage facilities, equipment for rough handling of native material and carpenter shop. Two other buildings with simple laboratory accommodation for summer use. Experimental concrete and earth ponds. Inlet or cove with dam near mouth, and provided with pools for experiments in control of tidal interchange and freshwater inflow. Pools for trout rearing.

Vessels and boats. ZOARCHES, 90 feet long, Diesel crude oil engine of 75 H.P., speed 8 knots, cruising radius 1000 miles; with power winch, otter trawl, deck laboratory, and large hold amidships for experimental work.

DELPHINE, 28 feet long, high-speed gasoline engine, 12 H.P., speed 10½ knots.

SAGITTA, 24 feet long, low speed gasoline engine, 6 H.P., speed 6 knots.

Gear for hydrography, plankton collecting, dredging, and fishing.

Main residence, bedrooms for 34 persons, dining room for 44 persons.

Double cottage, each half with living room, bathroom, and bedrooms for four persons.

Double cottage, each half equipped with bedrooms, bathroom, living room, kitchen and dining room for a family of six.

*Staff:* Director, A. H. Leim. Assistant Pathologist, R. H. M'Gonigle. Assistant Hydrographer, H. B.

Hachey. Assistant Zoologist, R. A. McKenzie. Scientific Assistant, A. A. Blair. Clerical: 2. Maintenance and operation: 4.

*Provisions for visiting investigators:* Insofar as accommodation may be available, properly qualified and accredited investigators are welcomed, irrespective of the problems upon which they may be engaged, and given available facilities insofar as no expense to the biological Board is involved. Reports on work done are expected of all investigators by the end of the year as evidence of bonafides.

*Income:* The Government of Canada furnishes the funds for the operation, the amount for the fiscal year April, 1936 to March, 1937, being \$44,400.00.

*Provision for publication of results:* The Biological Board of Canada has the following publications, in which the results of work done at the Atlantic Biological Station appear.

Annual Report.

Journal, a volume of about 500 pages usually appearing each year, containing accounts of contributions to knowledge.

Bulletins of the Biological Board of Canada, for the comprehensive presentation of knowledge on particular subjects under investigation and in somewhat non-technical form.

Canadian Atlantic Fauna. Succinct descriptions of the species, with keys for ready identification and with figures illustrating diagnostic features.

Progress Reports of the Atlantic Stations, simple accounts of discoveries likely to appeal to the general reader interested in fisheries.

With the approval of the Board investigators may publish articles in outside journals.

#### Prince Edward Island Marine Station ('37)

(A sub-station of the Atlantic Biological Station, St. Andrews, N. B.)

*History or origin:* Established in 1929. Present building constructed in 1930.

*Location:* Ellerslie, P. E. I. The station is on a shallow inlet tributary to Malpeque Bay, P. E. I.

*Organization to which attached:* Biological Board of Canada.

*Purposes:* Chiefly for scientific investigations bearing on oyster culture. Also for general oceanographic and fisheries investigations of the Biological Board.

*Scope of activities:* Research only. (See Purposes).

*Equipment:* Space for six scientific investigators.

Running fresh and salt water. Electricity and gas. Two small gasoline boats.

*Staff:* Scientific: Dr. A. W. H. Needler, Zoologist in charge. Technical and clerical: None. Maintenance and operation: 1.

*Provisions for visiting investigators:* Investigators accepted as volunteers by the Biological Board are given facilities for work. Accommodation arranged individually with local residents.

*Income:* Included in amount for Atlantic Biological Station.

*Provision for publication of results:* As for Atlantic Biological Station.

#### Meteorological Service of Canada ('37)

*History or origin:* Established in 1872 primarily for the purpose of giving storm warnings for shipping on the Great Lakes and in the Maritime Provinces. It has developed until it now includes all the activities associated with Meteorological Services. In 1920 it began the investigation of the surface-water temperatures in the Pacific.

There was a fairly prevalent theory that the water temperatures on the Pacific had a definite bearing on the weather on the North American continent, especially during the winter, and to test this out, observations in connection with the same were undertaken in 1920. For the first two years various types of instruments were tried out, and as result it was decided to use thermographs of the mercury-in-steel type, installed in the intake of the condenser on the ship, as it was found these gave accurate sea-water temperatures and that at the depth of the intake the temperature did not differ appreciably from that at the surface. Thermographs were installed on the ships plying from Vancouver to Hong Kong in 1922 and there are now fourteen years of records on the sea-water temperatures on the ship lanes in the North Pacific. In 1928 a thermograph was installed on one of the ships running from Vancouver to New Zealand and Australia. In 1930 a number of the ships of the Canadian Pacific Steamship Co. took the route from Vancouver to Yokohama via Honolulu, and as a consequence, observations have also been obtained over this route during this period.

*Location:* Toronto, Ontario, Canada.

*Organization to which attached:* Department of Transport—Dominion Government.

*Purposes and scope of activities:* This particular division of the Meteorological Service investigates

sea-water temperatures and their relation to the climate and weather of Canada.

*Equipment:* Fully equipped Meteorological Service at Toronto; Branch Office, Victoria; Office, Vancouver—for ocean temperature observations.

*Staff:* J. Patterson, M.A., F.R.S.C., Director; W. A. Thorn, M.A., in charge, Victoria; E. B. Shearman, in charge, Vancouver.

*Provisions for visiting investigators:* None.

*Income:* Received from Dominion Government.

*Provision for publication of results:* Publications of the Meteorological Service and various scientific periodicals.

#### Station Biologique du Saint-Laurent ('37)

*History or origin:* Founded in spring of 1931 by Laval University, Quebec, P. Q., as a section of the Institute of Marine Biology of that University.

*Location:* Trois-Pistoles, P. Q., 160 miles down the river from Quebec City, on the Saint Lawrence.

*Organization to which attached:* Laval University, Quebec City.

*Purposes:* To study the chemical and physical conditions as well as the fauna and flora of the Saint Lawrence estuary.

*Scope of activities:* The Station is open during the summer months only, from the middle of June until September, as the work is done mostly by men of the University of Laval (Quebec) or of Montreal.

*Equipment:* A small laboratory for biological and chemical work, a fine boat equipped with all necessary apparatus for dredging, collecting of water samples with the reversing bottle, collecting of plankton with microplankton and macroplankton meter nets such as are used by the United States Bureau of Fisheries. The equipment is quite adequate for the work to be done.

*Staff:* Director, Rev. Prof. Alexandre Vachon, Laval University.

*Biologists:* Dr. J. L. Tremblay, Prof. of Marine Biology, Laval University; Dr. Georges Préfontaine, University of Montreal; Mr. L.-P. Dugal, Montreal University; Dr. V. D. Valdykov, Biological Board of Canada, Halifax; Dr. A. R. Potvin, Professor of Biology, Laval University; Rev. R. Dolbec, Laval University; Rev. A. Gagnon, Laval University; Rev. L. Larouche, Chicoutimi, P. Q.; Mr. L.-P. Pigeon, Quebec; Mr. P. Demers, Montreal; Mr. R. Deschenes, Trois-Pistoles, P. Q.

*Chemists:* Dr. Lucien Gravel, Laval University;

*Staff:* Dr. Joseph Risi, Laval University; Mr. Richard Bernard, Quebec; Mr. L.-P. Bouthillier, Montreal University; Mr. Malcolm Vachon, Laval University; Mr. Aristide Nadeau, Laval University; Mr. Roger Gaudry, Laval University. Captain of boat: Mr. P.-E. Cloutier. Engineer: Mr. P. Fillion. Mate: Mr. J. Dumas.

*Provisions for visiting investigators:* Provisions may be made for a few workers if application is made to the Director early in the spring; all necessary information will be given.

*Income:* The Station is supported by Laval University. The amount granted by the University varies; it may average \$10,000 a year.

*Provision for the publication of results:* Results are published by the University as reports come in; they are sometimes published in "Le Naturaliste Canadien," a review of the University, and special reports are afterwards printed and sent a couple of times a year.

#### NEWFOUNDLAND

##### Fishery Research Laboratory of Department of Natural Resources

*(Date of information, April 19, 1937. Changes in the staff are contemplated for the near future)*

*History or origin:* Following upon a survey by Dr. Harold Thompson of the Newfoundland fishery situation in 1930, the British Empire Marketing Board and the Government of Newfoundland entered into an agreement providing for a five year period of fishery research in Newfoundland. At first the laboratory was established under a Fishery Research Commission, but later was taken over by the Dept. of Natural Resources. The original five year agreement was extended for one year and it will be continued for a further period, probably of five years.

*Location:* At Bay Bulls, a settlement 18 miles by road from St. John's.

*Organization to which attached:* The Department of Natural Resources, St. John's, Newfoundland.

*Purposes:* No scientific investigation of the fisheries of Newfoundland, the main industry of the Island, had been made up to 1931. The purpose of the Research Station was to rectify this want.

*Scope of activities:* Investigation of the life history, fluctuation and movements of the principal fishes of Newfoundland, and the improvement of existing methods, and the development of further

methods of processing fish products also receive attention.

*Equipment:* Part of the unused factory of Messrs. Harvey & Co., fish merchants, was at first rented. These premises were later bought by the Department of Natural Resources. They were originally erected with the object of carrying on a complete fishery business in conjunction with the deep sea fishing fleet, and contain freezing, smoking, drying, and cod liver oil plant, and a small canning plant and other additions have been installed. The Laboratory contains six laboratories, library, work shop well equipped, dark room, balance room, store rooms, and a small aquarium. The latter has pure sea water circulation. A research vessel is available. Originally a trawler with full commercial size trawling gear with usual scientific installments was run on regular spring and autumn surveys of the Newfoundland fishing area, but this has now been replaced by a diesel-engined refrigerated vessel. All heating is by electricity and steam, gas is not available.

*Staff:* Scientific: Director, vacant. Acting Director, Norman L. Macpherson, Ph.D., M.A. Anna M. Wilson, M.Sc. Nancy Frost, M.A. Allan R. Johnstone, B.Sc. Technical and clerical, 23. Maintenance and operation, 3.

*Provisions for visiting investigators:* The local hotel is suitable for summer residence.

*Income:* At first \$43,000 per annum, 50% from the E. M. B. and 50% from the Government of Newfoundland. Local scholarships have been provided for college students for part time work. Recently available funds were cut by some \$10,000 as cost is now borne entirely by the Newfoundland Government.

*Provision for publication of results:* Annual and Special Reports financed out of general expenditure. At first Reports of the Newfoundland Fishery Research Commission, now Department of Natural Resources, Division of Fishery Research Reports.

#### UNITED STATES

##### CONNECTICUT

##### Bingham Oceanographic Foundation ('37)

*History or origin:* The Bingham Oceanographic Collection was started privately in New York at the initiative of Harry Payne Bingham, who undertook three deepsea expeditions on his yacht PAWNEE during the years 1925-1927.

*Location:* New Haven, Connecticut.

*Organization to which attached:* Yale University, of which the Foundation with its collections and laboratories is a separate unit.

*Purposes and scope of activities:* The first expedition (1925) visited West Indian waters, the second (1926) explored the Gulf of California, and the third (1927) the waters around the Bahama Islands. The chief purpose of these expeditions was the collecting of marine life. During the first two expeditions, mainly shallow-water fishes and invertebrates were obtained, with numerous new species discovered. During the third expedition, the main emphasis was placed upon bathypelagic trawlings for which the yacht carried all the necessary equipment. In 1928 the collections were moved to Peabody Museum of Yale University, and in 1930 the Bingham Oceanographic Foundation was endowed by Harry Payne Bingham for the care and further increase of the collections, and to maintain the Bingham Oceanographic Laboratory for further oceanographic and marine biological research. After the last privately conducted expedition in 1927, the Bingham Oceanographic Foundation has coöperated with the United States Bureau of Fisheries in the investigation of the shallow-water biology of the middle Atlantic coast since 1929, this coöperation still continuing today. In this work the Bingham Laboratory has particularly undertaken to investigate the youngfish biology. Vessel and crew for the collecting has been furnished by the Bureau of Fisheries. In 1932 Yale University, through the Bingham Foundation, sent out an expedition to study the hydrography of the Gulf of Mexico on the schooner MABEL TAYLOR. Subsequently, this arrangement was superseded by a coöperative arrangement with the Woods Hole Oceanographic Institution for the further hydrographic exploration of the Central American seas, with joint expeditions to the Caribbean region on the ATLANTIS in 1933, 1934, 1936.

*Equipment:* The Bingham Oceanographic Laboratory is provided with all standard equipment for laboratory work on marine collections and also has the necessary apparatus for the standard chemical determinations of sea water. In regard to field equipment, the Foundation is completely provided with everything except a boat. Nets, seines, trawls, deepsea towing cables, electric winches, a hydrographic winch, and similar

equipment is maintained in readiness for installation on any available vessel.

*Staff:* Curator, A. E. Parr; Assistant Curator, Martin D. Burkenroad; Assistant, Yngve H. Olsen.

*Provisions for visiting investigators:* Although the space for the time being is rather limited, a table and the necessary equipment can always be provided for a visiting investigator.

*Income:* The total income derived from the Bingham Oceanographic Foundation, by annual contributions from Harry Payne Bingham and by a general oceanographic budget granted by Yale University, now amounts to \$10,800 per year.

*Provision for the publication of results:* Funds are provided for the printing and distribution of around two hundred pages of scientific reports each year. Two series of publications are maintained, the Bulletin and the Occasional Papers of the Bingham Oceanographic Collections.

*Supplement:* After this report had gone to press, under date of July 22, 1937, the following information was received from Dr. A. E. Parr of Yale University:

There has just been established at Yale the Sears Foundation for Marine Research, the income of which will be from an endowment intended to yield \$4,000.00 annually. This Foundation will be permanently associated with the Bingham Oceanographic Foundation at Yale. The chief purpose will be to support two series of publications, as follows:

First, a quarto memoir series, in which will be published the results of the investigations conducted under the auspices of both the Sears and the Bingham Foundations.

Second, an octavo periodical journal, which will afford means for the publication of results from any kind of marine research, including such diverse subjects as marine meteorology, deep-sea biology, and the chemistry of sea-water. It is intended to publish three numbers, with a total of about 200 pages annually. Only papers of an interpretative or a theoretical nature will be accepted. Articles that are merely descriptive and reviews of literature will not be published. A charge will be made for subscription to the journal, but funds derived from that source will be used to improve and augment the size of the magazine.

## DISTRICT OF COLUMBIA

**Department of Terrestrial Magnetism, Carnegie  
Institution of Washington ('37)**

*History or origin:* The Department of Terrestrial Magnetism was founded through the initiative of Dr. Louis A. Bauer, who submitted in 1902 to the Trustees of the Carnegie Institution of Washington a plan for an international magnetic bureau. This plan was supported by leading investigators in terrestrial magnetism and terrestrial electricity at home and abroad. The purpose of the proposed bureau was "to investigate such problems of worldwide interest as relate to the magnetic and electric conditions of the Earth and its atmosphere, not specifically the subject of inquiry of any one country, but of international concern and benefit." The Department was formally established under the auspices of the Carnegie Institution of Washington in general accordance with this plan April 1, 1904.

One of the chief problems undertaken was the magnetic survey of the oceans as a part of the problem of the world-wide survey. The magnetic survey of the oceans was begun in the Pacific Ocean and was continued during August 1905 to May 1908 with the chartered brigantine GALILEE, which had been adapted for the purpose of magnetic observations at sea. The success of these cruises and the importance of disclosing errors in magnetic charts led the Institution to authorize the construction of a non-magnetic ship, the CARNEGIE. This vessel was launched June 12, 1909, and carried on work in all oceans between latitudes 80° north and 61° south until November 29, 1929, when she was destroyed by an explosion while in the harbor at Apia, Samoa. The combined aggregate of the three cruises of the GALILEE and of the seven cruises of the CARNEGIE was 361,413 nautical miles.

When the CARNEGIE was overhauled preparatory to her seventh cruise (May 1928 to November 1929), laboratories were built and equipment was added so that in addition to continued magnetic and electric work an intensive program of physical and chemical oceanography and marine biology might be executed. The results included physical and chemical observations at 162 stations (in general from surface to bottom), 1,014 biological samples, 1,500 sonic depths, and 87 bottom-samples. The cruise covered the northern and southwestern portions of the North Atlantic, and

the eastern portion of the South Pacific Ocean and the North Pacific Ocean.

The central laboratory, offices, and shop of the Department were located in rented quarters in Washington from 1904 to February 1914, when site and laboratory-building were provided five miles northwest of the business section of Washington, D. C. A special non-magnetic standardizing observatory was built in 1914 and a special non-magnetic laboratory in 1918, to which was added in 1933 a large extension, designed particularly for research in nuclear physics. Dr. Louis A. Bauer was Director through 1929 and thereafter Director Emeritus until his death April 12, 1932. Dr. John A. Fleming, Assistant Director from 1922, Acting Director from 1930, became Director January 1, 1935. The annual grant of the Institution for maintaining the Department increased from about \$20,000 in 1904 to about \$189,000 in 1937, with a peak of about \$265,000 in 1929, at the end of which year the CARNEGIE was lost.

*Location:* The Department occupies a site of nine acres about five miles northwest of the center of Washington, D. C.

*Organization to which attached:* Carnegie Institution of Washington, of which the Department is a unit.

*Purposes:* Major, research in terrestrial magnetism and terrestrial electricity; oceanographical observations and research with particular reference to the continuous changes taking place in the Earth's magnetic and electric fields, particularly over oceanic areas; oceanographical research in connection with magnetic surveys at sea; theoretical and experimental investigations in nuclear physics in connection with their bearings on terrestrial magnetism and electricity; continuous observations of the magnetic and electric elements and of ionization of the upper atmosphere (ionosphere) at stations in Peru and Western Australia.

*Scope of activities:* Researches in terrestrial magnetism and electricity and cosmical relations; magnetic surveys over oceans and on land; continuous recording of magnetic and electric phenomena; researches on the physics and chemistry of sea-water samples and data, on the biological collections, on the meteorological results, and on marine bottom-samples, obtained during Cruise VII of the CARNEGIE.

*Equipment:* 1 laboratory building, 4 floors, 52 x 102 feet, with deck 29 x 79 feet, and underground constant-temperature rooms.

1 non-magnetic laboratory building for standardization of magnetic instruments, 1 floor, 26 x 58 feet.

1 experiment building, 28 x 53 feet, with extension 34 x 47 feet, and basement 34 x 47 feet.

Library, more than 8,000 volumes and 15,000 reprints.

Several service buildings and foundry (temporary structures).

9-acre site at Washington, D. C.

Magnetic, electric, seismological, radiotelegraphic, spectrohelioscopic, and auxiliary buildings and living quarters for observatory, operated from 1921, and located on 25-acre site acquired late in 1919 near Huancayo, Peru, 125 miles east of Lima.

Magnetic, electric, radiotelegraphic, spectrohelioscopic, and auxiliary buildings and living quarters for observatory, operated from 1919, and located on 220-acre site acquired in 1917 near Watheroo, Western Australia, about 120 miles north-northeast of Perth.

During 1909 to 1929 non-magnetic vessel CARNEGIE with special equipment, an auxiliary brigantine of 568 tons displacement, of 33-foot beam, and 155 feet long over all.

*Staff:* Dr. J. A. Fleming, Director (terrestrial magnetism and electricity, oceanography, field and observatory operations).

O. H. Gish, Physicist and Assistant Director (terrestrial electricity).

W. J. Peters, Research Associate (compass-deviations, magnetic disturbances).

Dr. S. Chapman, Research Associate (magnetic and electric theory).

Dr. J. Bartels, Research Associate (magnetic activity and correlations).

Dr. H. U. Sverdrup, Research Associate (oceanographical research).

Dr. G. Breit (nuclear physics theory).

Dr. G. Gamow (nuclear physics).

H. F. Johnston, Physicist (magnetic variations).

Dr. M. A. Tuve, Physicist (nuclear physics).

L. V. Beckner, Physicist (ionospheric research).

Dr. G. R. Wait, Physicist (atmospheric electricity).

Dr. L. R. Hafstad, Physicist (nuclear physics).

W. J. Rooney, Physicist (earth-currents).

Dr. N. P. Heydenburg, Associate Physicist (nuclear physics).

W. C. Parkinson, Magnetician (terrestrial magnetism).

W. F. Wallis, Magnetician (terrestrial magnetism).

J. W. Green, Magnetician (magnetic secular-variations and land-survey).

A. G. McNish, Magnetician (magnetic and electric theory).

E. A. Johnson, Mathematical Physicist (electromagnetic design and theory).

C. R. Duvall, Expert Computer (secular variation and harmonic analysis).

C. C. Ennis, Computer (oceanographical and magnetic research).

F. T. Davies, Computer (observatory work).

C. W. Torreson, Observer (atmospheric electricity).

P. G. Ledig, Observer (observatory and land magnetic survey).

W. E. Scott, Observer (observatory work).

S. L. Seaton, Observer (observatory ionospheric research).

S. E. Forbush, Observer (magnetic and electric theory).

H. W. Wells, Observer (ionospheric research).

W. W. Culmsee, Observer (observatory work).

K. L. Sherman, Assistant Physicist (atmospheric electricity).

R. C. Meyer, Assistant Physicist and Instrument-maker (nuclear physics and instrumental designer).

H. W. Graham, Biologist and Chemist (research on biological collections of CARNEGIE).

W. F. Steiner, Chief Instrument-maker (instrumental designer).

Two junior observers and one hand, in addition to Observer-in-Charge and his two staff-assistants, at Watheroo Magnetic Observatory (observatory operation).

One observer, two clerical assistants, and four general assistants and hands, in addition to Observer-in-Charge and his one staff-assistant, at the Huancayo Magnetic Observatory (observatory operation).

*Provision for visiting investigators:* In addition to the Institution's staff, there are occasional visiting investigators at the laboratory in Washington. Accommodations for such visiting investigators are somewhat limited, although as many as four or five visiting investigators can be accommodated at one time.

*Income:* The annual grant of the Department for 1937 from the Carnegie Institution of Washington is about \$189,000. This amount varies somewhat from year to year. In addition, private con-

tributions for special purposes are received from time to time; these are, in general, for small amounts.

*Provisions for publication of results:* The Carnegie Institution of Washington through its Division of Publications publishes a series entitled "Researches of the Department of Terrestrial Magnetism," of which six quarto volumes have been issued. Material for an additional volume has been made ready for publication, and manuscripts for the first volume of oceanographic data—physical, chemical, and biological—obtained on Cruise VII of the *CARNEGIE* are ready. The members of the staff publish papers in various American and foreign scientific periodicals; the total number of such papers since 1904 is nearly 1,500. The Department publishes each year lists of all its publications, and all publications are supplied free of charge so far as the limited editions permit.

#### United States Coast and Geodetic Survey ('37)

*History or origin:* (a) In 1807, during the administration of President Thomas Jefferson, Congress authorized the establishment of a national Coast Survey as a bureau under the Secretary of the Treasury. The plan adopted for its execution was that submitted by Ferdinand R. Hassler. Because of the external relations of the country it was impracticable to take any steps toward putting the plan into operation until 1811, when Hassler was directed to proceed to Europe to arrange for the construction of the necessary instruments and standards, some of the most important of these being made after his own design. The outbreak of the War of 1812 seriously interfered with his commissions, their completion being thereby delayed until the close of 1815, and in consequence actual field work was not possible until 1816. The work was suspended in 1818 and resumed in 1832.

For the purpose of furnishing geographic positions and other data to State surveys the scope of the bureau was enlarged in 1871, and in 1878 its designation became the Coast and Geodetic Survey.

On the organization of the Department of Commerce and Labor in 1903 the bureau was transferred to it from the Treasury Department and in 1913 to the Department of Commerce. The plan upon which it is at present organized is based on the broad scientific foundation pro-

posed by Hassler and approved by Jefferson; and its present methods are the perfected results of experience gained in the field and office during more than a century of its existence.

Under the direction of a director there are two main divisions of its work—the field and the office. In accordance with the plan of reorganization of 1843, the work on shore was divided between civilian assistants and officers of the Army, and the hydrographic work was placed almost entirely in charge of officers of the Navy.

In 1861 the officers of the Army and Navy were detached, and since that date no officers of the Army have been assigned to duty on the survey. After the Civil War the assignments of officers of the Navy gradually increased in number, so that the hydrographic work was about equally divided between them and the civil assistants during the period which extended to 1898, when the officers of the Navy, because of conditions created by the outbreak of the war with Spain, were finally relieved, and in 1900 Congress authorized the establishment of the survey on a purely civil basis.

(b) Of the oceanographic accomplishments of the Coast and Geodetic Survey, these may be mentioned:

1. Study and investigation of the Gulf Stream, the Gulf of Mexico, and the Caribbean Sea. The work of the Survey ship *BLAKE*, under the command of Sigsbee and Bartlett, is particularly well known through the two volumes of Agassiz issued under the title "Three Cruises of the *BLAKE*," and by Pillsbury's classical investigation of the Gulf Stream.

2. The development and use of acoustic methods of determining both depth and position of soundings. Equipped with these methods, the Bureau is now able to delineate accurately the ocean bottom over any section of the continental shelves. The work that has been accomplished as a result of this development reveals the inadequacy of the data on which oceanographers in the past have based studies depending on a knowledge of the configuration of the bottom in areas out of sight of land. Inasmuch as the use of the new methods requires a thorough knowledge of the temperature and salinity of the water, a large amount of information of this nature is being accumulated. Excellent examples of the contributions to oceanography resulting from the new methods are the results obtained

on the recent survey of Georges Bank, the approaches to New York Harbor, and the approaches to Chesapeake Bay.

In the subject of tides, three notable achievements may be mentioned. First is the design of the construction of a direct-reading tide predictor by means of which tide predictions are made more expeditiously and more accurately than before. Second, the development of methods for determining with precision tidal datum planes from short series of observations. Third, the development of the stationary-wave theory of the tide, which permits a better understanding of the various features of the tide found in the seven seas.

*Location:* Washington, D. C.

*Organization to which attached:* Bureau of Department of Commerce.

*Purposes and scope of activities:* The results of coastal surveys are published, for the guidance of navigation and the protection of life and property at sea, on about 750 different charts which constitute the basic product of the Bureau. The greater part of the information shown on the charts is obtained by extensive hydrographic and topographic surveys and the accuracy and adequacy of such surveys in any region are, therefore, an index of the condition of the charts of that region.

There is also a considerable amount of information required by mariners that can not be shown conveniently on charts. This includes sailing directions and data relative to port facilities, weather conditions, radio service, and similar subjects. To supply this information the Coast and Geodetic Survey publishes 12 Pilot volumes for the coasts under the jurisdiction of the United States and 3 Inside Route Pilots for our inland waterways.

The geodetic work of the Bureau has for its principal object the establishment of a great number of points, distributed along our coasts and throughout the interior, to provide a foundation or framework for practically all charting and mapping operations. These are divided into two general classes—triangulation stations, the positions of which, with relation to each other and on the surface of the earth, are determined; and bench marks, the elevations of which are accurately known.

The bureau's tidal investigations serve two purposes with respect to chart production; first, they provide data for the establishment of the

reference plane and for the reduction of all soundings to that plane; second, they enable the bureau to compile annual tables of predicted tides and currents, by means of which the mariner can time the movements of his ship to take advantage of the tide or, by using the tables in conjunction with his chart, can ascertain the actual depths at any time.

With the increase in size of ships and the growing importance of economy in their operation, it has been necessary in late years for the bureau to extend the scope of its current investigations which are carried on in connection with tidal observations. Outside the bureau the results of these operations are of great value in harbor-improvement work, sewage disposal, and similar projects.

The magnetic surveys of the Bureau are carried on for the primary purpose of providing the data relative to magnetic variation that are shown on all charts and airway maps and are essential to the accurate use of the magnetic compass. The results are equally necessary for land surveying and for many branches of scientific research.

The activities mentioned above are all essential branches of chart and map production work, however, the Bureau is engaged in two other activities. One of these is airway mapping. In addition to being directly in line with other charting operations, the assignment of this duty to the Bureau is simply a case of utilizing trained personnel and a modern map-making plant to turn out additional work with no great increase in overhead expenses.

The other activity is seismology, or earthquake investigation. This was delegated to the bureau for the reason that the work required is admirably adapted, both in the field and office, for prosecution in conjunction with magnetic surveys and, like airway mapping, can be carried on with only a moderate increase in operating expenses.

The Coast and Geodetic Survey helps other institutions by collecting samples of marine plankton and bottom sediments.

*Equipment:* The Survey owns and operates ten sea-going vessels, four of which are employed on the Atlantic and Gulf Coasts, six on the Pacific and Alaskan Coasts, and one in the Philippine Islands. The last is owned by the Philippine Government. In addition, it operates a number of smaller motor vessels and wire drag launches for work imme-

diately adjacent to the coast and a large number of trucks for work in the interior of the country.

The various surveying units are each equipped with the most modern surveying instruments and appliances for undertaking the work assigned to them. The Washington office, located in the new Department of Commerce building, is adequately equipped to handle the material received from the field and to convert it into the various products of the Bureau.

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
OCEANOGRAPHER.....	1,400	12	59
SURVEYOR.....	1,150	11	59
DISCOVERER.....	1,180	12	57
GUIDE.....	1,180	12	57
PIONEER.....	1,180	12	57
PATHFINDER.....	875	9	71
LYDONIA.....	585	7	49
FATHOMER.....	550	7	41
EXPLORER.....	450	7	45
HYDROGRAPHER.....	987	10	51
GILBERT.....	90	3	12
WESTDAHL.....	90	3	12

Also 13 enclosed power launches of from 25 to 45 tons displacements, 2 to 4 officers, 5 to 10 crew.

*Staff:* Director, Hydrographic & Geodetic Engineer, Rear Admiral R. S. Patton.

Assistant-Director, Hydrographic & Geodetic Engineer, Commander J. H. Hawley.

Head of Division of Hydrography and Topography, Hydrographic & Geodetic Engineer, Captain G. T. Rude.

Head of Division of Geodesy, Hydrographic & Geodetic Engineer, Captain C. L. Garner.

Head of the Division of Charts, Hydrographic & Geodetic Engineer, Commander L. O. Colbert.

Head of Division of Terrestrial Magnetism and Seismology, Hydrographic & Geodetic Engineer, Captain N. H. Heck.

Head of the Division of Tides and Currents, Hydrographic & Geodetic Engineer, Captain P. C. Whitney.

Head of the Division of Instruments, D. L. Parkhurst.

Accountant, J. M. Griffin.

Chief Clerk, C. H. Dieck.

Field force composed of 171 hydrographic and geodetic engineers, junior hydrographic and geodetic engineers, and aides, 10 magnetic observers, 30 tide observers, 41 mates, engineers, surgeons, deck officers, etc., approximately 500 enlisted men, and an average of 160 additional

employees who are necessary to insure the effective work of shore parties, besides a number of laborers hired for brief periods when needed.

Office force, composed of mathematicians, cartographers, draftsmen engravers, instrument makers, printers, accountants, clerks, etc., numbering 208.

There is a field station at Manila, and the officer in charge, representing the director, has authority to arrange for the conduct of insular field and office operations, and to prepare and publish charts and sailing directions for the Philippine Islands. There are field stations also at Boston, New York, New Orleans, San Francisco, Seattle, and Honolulu.

*Provisions for visiting investigators:* It would be of particular value if scientific workers outside of the Coast and Geodetic Survey could have the opportunity to utilize the large amount of scientific data now in its archives. It is probable that scientific men working at universities or in private research laboratories might be desirous of attacking certain problems by the use of the data of this Bureau. The studies might be of such a nature that the institution or laboratory could not or would not finance the investigations. If Congress would authorize having studies made at the Washington office by outside scientific men and, while they were being made, would pay salaries that would be sufficient to cover at least the living expenses of the workers, men from educational institutions might work here during their Sabbatical years or during the usual summer vacation. The cost of such investigations would be quite small but the product might be of marked value.

*Income:* Source: Federal appropriation.

Amount: Approximately \$3,000,000 per annum.

*Provision for publication of results:* Publishes its own nautical charts, and Department of Commerce Aeronautical charts. Receives allotment from Department of Commerce for standard publications such as Coast Pilots, Tide and Current publications, triangulation, leveling, and magnetic and seismological data. Papers are also published in various scientific journals.

#### United States Coast Guard ('37)

*Location:* Washington, D. C.

*Organization to which attached:* United States Treasury Department.

The following is a statement prepared by Rear

Admiral R. R. Waesche, the Commandant of the Coast Guard, in addition to that on the International Ice Patrol on a preceding page:

Each year the United States Coast Guard details a force of vessels to the Bering Sea in the performance of the duties of the Coast Guard in those waters during the season of marine activities. These duties involve the cruising of the vessels throughout all sections of the Bering Sea, affording opportunities, at times, for oceanographic observations, and thus contributing to the meager knowledge now available bearing upon currents, bathymetry, water temperatures, and other oceanographic data applicable to that region.

During the season of 1934 the Coast Guard cutter *CHELAN*, under the command of Commander F. A. Zeusler, U. S. C. G., in collaboration with the Oceanographic Laboratory of the University of Washington, conducted a survey of the physical and chemical conditions of the surface waters from the Strait of Juan de Fuca to Dutch Harbor, Alaska, during the regular passage of the cutter from Seattle en route to Bering Sea Patrol duty. From July 26 to August 24, 1934, the oceanographic party aboard the *CHELAN* made a study of the chemistry of the Bering Sea ocean floor, of the ocean water, and of the various organisms and plants, and of the water circulation, water temperatures, etc. throughout a major portion of the Bering Sea area. The results and discussion of the data obtained during this cruise have been published in a Coast Guard bulletin, dated June 1, 1936, entitled "Report of Oceanographic Cruise, United States Coast Guard cutter *CHELAN*, Bering Sea and Bering Strait, 1934."

During the season of 1935 and 1936, the Coast Guard cutter *CHELAN*, in command of Commander L. V. Kielhorn, U. S. C. G., in furtherance of the studies carried on during 1934, conducted an oceanographic survey of the waters in the general region of Bowers Bank, Bering Sea (in 1935), and of the waters to the westward and southward of Attu Island (in 1936). These observations developed the presence of a submarine plateau, previously uncharted, in Western Bering Sea, and indicated that, contrary to the general belief formerly entertained, shoal water existed between the Kormandorkis and the Aleutian Chain, and that deep water existed in the Aleutian Trough. The soundings data obtained during the *CHELAN*'s

cruises of 1935 and 1936 are recorded on charts published in the above-mentioned bulletin.

Recognizing the value and importance of oceanographic observations in the Bering Sea and North Pacific Ocean region, the Coast Guard plans to continue such work as opportunity offers in the course of the regular cruising activities of its vessels in that area.

#### United States Bureau of Fisheries ('37)

*History or origin:* The Bureau of Fisheries, the sole Federal Agency concerned with the conservation and utilization of the nation's aquatic resources, owed its inception to the widely entertained opinion that the fisheries in general were diminishing in value and importance on account of the intensity and methods with which they were prosecuted, a view which investigation has shown to be justified with regard to many fishes and other valuable aquatic animals. The American Fish Culturists Association (now the American Fisheries Society) took a leading part in advocating investigation of the subject, and largely through its influence and the representations of State fisheries officers, Congress passed a joint resolution, approved February 9, 1871, which provided for the appointment of a Commissioner of Fish and Fisheries who was directed to conduct investigations concerning the facts and the causes of the alleged diminution and the feasibility of remedial measures. Until July 1, 1903, the establishment was independent, reporting directly to Congress, and was known as the U. S. Commission of Fish and Fisheries, but on the organization of the Department of Commerce, it was included by law in the new department, and the name was changed to its present designation.

*Location:* The central office is in the Department of Commerce Building, Washington, D. C. Permanent biological laboratories, experimental stations, and fish cultural stations are located in 39 states and Alaska. Temporary field headquarters for various investigations are maintained in many of the leading universities.

*Organization to which attached:* United States Department of Commerce.

*Purposes:* The original conception of the Bureau was a body for scientific and statistical investigation of the fisheries and that phase of its work always has been prominent, but it was soon found that to secure the practical end which effected its formation it should be clothed with the power

that would make its own findings effective. This was in part accomplished by the Act approved June 10, 1872, which gave authority for the propagation of food fishes, a branch of the service which has grown until at present it constitutes an important part of the bureau's activities.

*Scope of activities:* As now constituted, the Bureau is concerned with the wise husbandry of our fishery resources. Its work includes the collection of biological and statistical data to reveal the condition and trend of our important fisheries, the development of the science of aquiculture, the propagation and distribution of food and game fishes to replenish the natural supply, the conduct of economic and technological studies to assure maximum utilization of fishery products and by-products, the protection of the sponge fishery off the coast of Florida, the protection and conservation of the salmon and other fisheries of Alaska, the administration of the fur seal herd on the Pribilof Islands, and enforcement of the Act of July 2, 1930, regulating the interstate transportation of black bass. Acting in an advisory capacity, the Bureau has been able to exert a powerful influence on the fishery legislation of the States. Local authorities and interests hold its work in high regard and, appreciating that its advice is authoritative and disinterested, frequently seek it. The Bureau is also represented on Commissions having to do with international fisheries questions of conserving the supply of aquatic animal life.

The scientific work of the Bureau is conducted by the staff of the Division of Scientific Inquiry, and the information presented below refers primarily to that Division. The research program is divided into three major branches: (1) Commercial fishery investigations, relating to variations in the supply of important food fishes and the causes of such variations, such as may be found in the life history of the various species, their ecological relationships, including the effects of commercial fishing and changes in their environment which involves a limited program of oceanographic research; (2) Shellfishery Investigations, including studies on the physiology and ecology of oysters and other shellfish and the practical problems of oyster farming; and (3) Aquicultural Investigations, including the feeding, breeding, and rearing of food and game fishes; the survey and improvement of streams, and the development of an effective policy of

stocking interior waters and overcoming the effects of pollution of streams.

*Equipment:* Fisheries Biological Laboratory and Hatchery, Woods Hole, Massachusetts. Laboratory and hatchery building, three floors, containing marine fish hatchery, public aquarium and exhibit room, offices, general laboratory with alcoves, private research rooms, chemical laboratories, stock room, dark room, and library. Residence building, three floors; power house and storage building. Dock, breakwater, boat harbor, etc. Running salt water supply. One diesel driven research boat, 45 feet long, with live well and hoisting equipment; two 26 foot launches; row boats.

Fisheries Biological Laboratory, Beaufort, N. C. Laboratory building, two floors, containing main laboratory with alcoves, private research rooms, chemical laboratory, exhibit room, offices, library, dark room, stock rooms, etc., and 12 dormitory rooms. Mess hall; power house; boat house; carpenter shop; residence; dock; 46 foot motor cruiser, 35 and 26 foot launches; numerous row boats. Circulating salt water supply.

Fisheries Biological Laboratory, Fairport, Iowa (temporarily closed). Laboratory building, three floors, including offices, exhibit room, private research rooms, chemical laboratories, dormitories, library, and dining rooms. Tank house, power house, carpenter shop, boat house, 5 residence buildings, and 2 river launches. Approximately 15 acres of earthen and concrete ponds supplied with river and well water.

Fisheries Biological Laboratory, Seattle, Washington. Laboratory building, three floors, containing offices, private research rooms, chemical laboratories and stock room, photographic rooms, and library. 40 foot motor launch.

Experimental Fish Cultural Station, Pittsford, Vermont. Hatchery building, small laboratory building, residence and accessory buildings, ponds and raceways for experimental trout culture.

Experimental Fish Cultural Station, Leetown, West Virginia. Large hatchery and laboratory building, including offices, library, dark room, research rooms, and biological laboratory. Shop and storage building, residences, numerous ponds and raceways for experimental trout culture and ponds for culture of bass and other warm water fishes (approximately 60 acres when completed).

Laboratories and offices well equipped for experimental and statistical biological research

are coöperatively maintained at Harvard University, Yale University, Cornell University, University of Michigan, University of Missouri, and Stanford University.

*Staff:* Washington Office:

Elmer Higgins, Chief Division of Scientific Inquiry.

E. W. Bailey, Junior Administrative Assistant.

Dr. S. F. Hildebrand, Senior Ichthyologist.

Isaac Ginsburg, Assistant Aquatic Biologist.

3 clerical assistants.

Office of Experimental Fish Culture: Dr. H. S. Davis, Pathologist, in charge.

Office of Shellfishery Investigations: Dr. P. S. Galtsoff, Aquatic Biologist, in charge.

*Field Organization:*

Commercial Fishery Investigations:

North and Middle Atlantic Fishery Investigations, Cambridge and Woods Hole, Mass.: O. E. Sette, in charge; W. C. Herrington, Aquatic Biologist; R. A. Nesbit, Assistant Aquatic Biologist; J. R. Webster, Junior Aquatic Biologist; 4 clerical and technical assistants.

South Atlantic and Gulf Shrimp Investigations, New Orleans, La.: M. J. Lindner, in charge; Dr. Lionel A. Walford, Associate Aquatic Biologist; J. C. Pearson, Assistant Aquatic Biologist; W. W. Anderson, Junior Aquatic Biologist (Brunswick, Ga.).

Great Lakes Fishery Investigations, Ann Arbor, Michigan: Dr. John Van Oosten, in charge; Dr. Ralph Hile, Assistant Aquatic Biologist; Dr. H. J. Deason, Assistant Aquatic Biologist; 1 clerk.

Pacific Coast and Alaska Fishery Investigations, Seattle, Wash.: Dr. F. A. Davidson, in charge; J. A. Craig, Associate Aquatic Biologist; H. B. Holmes, Associate Aquatic Biologist; Dr. G. A. Rounsefell, Junior Aquatic Biologist; E. H. Dahlgren, Junior Aquatic Biologist; A. J. Suomela, Junior Aquatic Biologist; Frank Jobes, Junior Aquatic Biologist; 2 temporary and 2 permanent clerical and maintenance assistants.

*Shellfishery Investigations:* New England Oyster Studies, Milford, Conn.: Dr. V. L. Loosanoff, Assistant Aquatic Biologist. South Atlantic Oyster Studies, Beaufort, N. C.: Dr. H. F. Prytherch, Director; 4 clerical and maintenance assistants. Gulf

Oyster Studies, Apalachicola, Florida: Dr. A. E. Hopkins, Senior Aquatic Biologist; R. O. Smith, Assistant Aquatic Biologist.

*Fish Cultural Investigations:* Experimental Hatchery, Pittsford, Vermont: R. F. Lord, Junior Aquatic Biologist; 2 Fish Culturists. Experimental Hatchery at Leetown, West Virginia: E. W. Surber, Assistant Aquatic Biologist; Dr. J. S. Gutsell, Associate Aquatic Biologist; 3 Fish Culturists. Pond Cultural Experiments at Marion, Alabama: O. L. Meehan, Junior Aquatic Biologist. California Trout Investigations, Stanford University, Calif.: Dr. P. R. Needham, Associate Aquatic Biologist; A. C. Taft, Associate Aquatic Biologist; 12 temporary assistants. Pathological Laboratory, Seattle, Washington: Dr. F. F. Fish, Associate Pathologist. Investigations in the Interior Waters, Columbia, Missouri, and Fort Worth, Texas: Dr. M. M. Ellis (temporary), in charge; T. K. Chamberlain, Associate Aquatic Biologist; 6 temporary assistants.

*Provisions for visiting investigators:* Formerly facilities for research in aquatic biology have been provided free of charge to competent investigators at the Bureau's laboratories at Woods Hole, Mass., Beaufort, N. C., and Fairport, Iowa. During the current year, owing to reduced appropriations, facilities are available only at Beaufort, N. C.

*Income:* The Bureau receives regular annual appropriations from Congress. In 1932, \$2,905,540 was appropriated for the Bureau, of which \$300,340 was for the Division of Scientific Inquiry. During 1934 upwards of \$1,000,000 has been received from various emergency and Public Works organizations. For the fiscal year 1937, the Bureau's appropriation is \$1,565,920, of which \$164,700 is for the Division of Scientific Inquiry.

*Provision for the publication of results:* Publications of the Bureau of Fisheries include the following: *Administrative Reports*, containing the annual report of the Commissioner and the four Divisions; *Investigational Reports*, including the results of research in applied science in the fields of biology, technology, economics, and statistics of the fisheries; *Bulletin*, including scientific contributions on biological subjects; *Fishery Circulars*, consisting of brief accounts of investigations having economic importance or general interest

and including information of timely significance not requiring more extensive treatment; *Statistical Bulletins* (multigraphed), consisting of statistical and trade information regarding the commercial fisheries and the marketing and distribution of fishery products. In 1932, \$27,000 was available for publications; during the current year \$14,000 was available.

#### Hydrographic Office, United States Navy ('37)

*History or origin:* On December 6, 1830, following a recommendation by Lieutenant L. M. Goldsborough, United States Navy, to the Board of Navy Commissioners, a "Depot of charts and instruments" was established at the seat of Government. This depot took charge of such nautical charts and instruments as had been collected at the various navy yards and assumed the care and issue of charts and instruments furnished United States vessels. The object of the depot was to do away with the difficulties and dangers to which our national vessels had been previously exposed from want of an orderly and sufficient supply of information on all parts of the world to which their services might be directed.

The difficulties that were experienced in maintaining an adequate supply of charts, all of which were purchased from civilian firms, early led to a recommendation from the Board of Navy Commissioners to the Secretary of the Navy that means for providing charts should be installed at the depot. The introduction of a lithographic press in May, 1835, constituted the initial attempt at chart production.

In 1842 the Board of Navy Commissioners that had governed the Navy for twenty-seven years was dissolved and the present bureau system was established in its place. The depot of charts and instruments was placed under the Bureau of Ordnance and Hydrography. The institution was officially known from 1830 to 1844 as the "Depot of Charts and Instruments," but during the next ten years the names "Naval Observatory," "National Observatory," "Hydrographic Office," and others were used indiscriminately. By order of the Secretary of the Navy, in December 1854, it was thenceforth called the United States Naval Observatory and Hydrographical Office. As such it was known until the statutory establishment of the Hydrographic Office as a separate institution in 1866. During the years 1842-1861 in which

Lieutenant M. F. Maury, United States Navy, was in charge of the instruments, his talents and inclinations being essentially those of a meteorologist and oceanographer, he became recognized as taking account of scientific matters in general relating to the ocean. His investigations and writings on the winds which blew over the surface of the water and their agencies in minimizing the duration of the passage of ships; the configuration of the ocean bed from the sea level down to the greatest depth; the temperature, circulation, and physical and chemical properties of sea water; the currents; the tides; the waves; the composition and distribution of marine deposits; the nature and distribution of marine organisms; the relation of man to the ocean in the development of fisheries; commerce, civilization; navigation; hydrography; and marine meteorology were all subjects within the purview of this naval scientist.

In 1866 Congress passed an act to establish a Hydrographic Office, thereby severing the connection between that office and the Naval Observatory. This act reads in part as follows:

"There shall be a Hydrographic Office attached to the Bureau of Navigation in the Navy Department, for the improvement of the means for navigating safely the vessels of the Navy and of the mercantile marine, by providing, under the authority of the Secretary of the Navy, accurate and cheap nautical charts, sailing directions, navigators, and manuals of instructions for the use of all vessels of the United States, and for the benefit and use of navigators generally. (U. S. Code, Title 5, sec. 457.)

The Secretary of the Navy is authorized to cause to be prepared, at the Hydrographic Office attached to the Bureau of Navigation in the Navy Department, maps, charts, and nautical books relating to and required in navigation, and to publish and furnish them to navigators at the cost of printing and paper, and to purchase the plates and copyrights of such existing maps, charts, navigators, sailing directions, and instructions, as he may consider necessary, and when he may deem it expedient to do so, and under such regulations and instructions as he may prescribe. (U. S. Code, Title 5, sec. 458.)"

In 1866 the Hydrographic Office was moved to what is known as the "Octagon House," at Eighteenth Street and New York Avenue. Commander Thomas S. Fillebrown, United States Navy, was detached from the Naval Observatory and appointed Hydrographer. In the summer of 1879 the Hydrographic Office was removed from the Octagon House to the same building in which the Navy Department was located, and it has

since been quartered along with the rest of the department. By act of Congress in 1898 it was transferred from the Bureau of Navigation to the Bureau of Equipment; and on July 1, 1910, it was transferred back to the Bureau of Navigation. The Hydrographic Office is supplemented by twenty fully equipped Branch Offices located at the most important points on the Atlantic, Pacific, and Gulf seaboard and on the shores of the Great Lakes, and at Honolulu, T. H. The Hydrographic Office is under the immediate direction of the Hydrographer, a naval officer of high rank. The present Hydrographer, Captain Lamar R. Leahy, United States Navy, assumed his duties on May 31, 1935.

*Location:* In the Navy Building, 18th Street and Constitution Ave., N. W., Washington, D. C.

*Organization to which attached:* The United States Navy Department, of which the Hydrographic Office is a major sub-division of the Bureau of Navigation.

*Purposes:* To place within reach of mariners, at small expense to them, such useful information as can not be collected profitably by a private individual, but which the Government can readily gather, without additional cost, through agencies already established, to collect, digest, and issue timely information calculated to afford the maximum possible safety and facility of navigation to ships on the seas and to aircraft operating over the sea routes.

*Scope of activities:* Under statutory obligations to:

(1) Produce epitomes and manuals for the guidance of navigators in conducting their observations and keeping their reckoning on the seven seas;

(2) supply the United States Navy with charts required by it;

(3) supply the Merchant Marine, United States and foreign, and the navigators and aviators generally, with Hydrographic Office charts and other publications "at the cost of printing and paper" (there are always on the shelves of the Hydrographic Office some 300,000 charts and 100,000 journals and books ready for issue);

(4) maintain the flow of the latest information about surface and aerial navigation with some 7,000 mariners and aviators of all nationalities who keep up a constant flow of information respecting the sea and the air of the world in addition to information from the vessels of the Navy, American consuls, scientific organizations,

and foreign governments; provide a free exchange of information and publications between the Hydrographic Office and the Hydrographic Offices of the other navies of the world;

(5) prepare, issue and keep up-to-date the numerous standard publications that the Hydrographic Office issues, such as sailing directions and light lists of foreign waters, flying directions and other aids to navigation, and all other navigational publications and charts;

(6) study oceanic circulation dynamically and otherwise;

(7) prepare special and strategic charts required by the Navy for its operation and maintain a sufficient supply of charts, navigational tables, and manuals necessary to enable the Navy to operate in accordance with approved war plans;

(8) supervise the operation of the branch offices, whereby the personal contact with merchant mariners is secured and maintained, for the purpose of collecting and disseminating information;

(9) conducting actual direction of the United States Naval surveying parties on the high seas, laying out detailed plans for such surveys, and working up the data secured into finished charts, and;

(10) maintain interchange of information and publications with scientific institutions, foreign hydrographic offices, and the International Hydrographic Bureau of Monaco.

*Equipment:* Comparable to any large well organized concern which not only manufactures and distributes its own products but in addition does its own scientific research work.

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
HANNIBAL.....	4,000	14	240
NOKOMIS.....	1,265	11	118
Y. P.—41.....			
Y. P.—42.....			
Y. P.—56.....	210	From NOKOMIS	

*Staff:* Sixteen officers and 176 civilians in the main office at Washington, D. C., with twenty officers and twenty-four civilians in the branch offices. The civilians are mostly nautical, hydrographic, and cartographic engineers; nautical scientists; computers, engravers; photographers and lithographers.

Officers in charge of Divisions, March 1937: Hydrographer, Captain L. R. Leahy, U.S.N.

Assistant Hydrographer and Head of Division of Administration, Captain H. E. Kays, U.S.N.

Head of Division of Maritime Security, Commander F. P. Traynor, U.S.N.

Head of Division of Chart Construction, Commander W. G. B. Hatch, U.S.N.

Head of Division of Distribution, Commander H. J. Nelson, U.S.N.

Head of Division of Air Navigation, Lieut.-Commander W. Sinton, U.S.N.

Head of Division of Research, Lieut.-Commander J. E. Gingrich, U.S.N.

*Provisions for visiting investigators:* No special provisions have been made for any definite number, but desk room is available for a few persons at a time.

*Income:* Appropriations by Congress vary from time to time. The 1937 appropriation was for the amount of \$701,600.00 allotted as follows: Salaries Hydrographic Office, \$400,000.00; maintenance and operation, including Branch Hydrographic Offices, \$136,600.00; printing, \$95,000.00; Ocean and Lake Survey, \$70,000.00.

*Provisions for publication of results:* The Hydrographic Office publishes fifty-six volumes of Sailing Directions, six volumes of Lists of Lights (foreign waters), two Naval Air Pilots, fourteen Manuals of Tables, and numerous miscellaneous books, among which are the two volumes of the International Code of Signals; about 2,900 navigational charts covering nearly every part of the world; 64 aviation charts; Pilot Charts of the surface of all oceans; Pilot Charts of the Upper Air of the North Atlantic and North Pacific Oceans and many other special charts, such as Great Circle Sailing, Star, Track and Distance, Time Zone Charts of the World; and Magnetic Declination Charts of the World. Papers are also prepared by the members of the staff for various scientific conventions and for publication in scientific periodicals.

#### United States National Museum

*History or origin:* Began in 1846 with founding of Smithsonian Institution.

*Location:* Washington, D. C.

*Organization to which attached:* Smithsonian Institution.

*Purposes:* Preservation and exhibition of the National Collections in natural history, arts and industries, history, and kindred subjects.

*Scope of activities:* Systematic research on collections which include extensive series representing the life of the sea.

*Equipment:* Museum building, laboratories, and storage space for collections; laboratory equipment required in systematic work.

*Staff:* Staff concerned principally with life from the sea includes the following:

Division of Fishes: L. P. Schultz, Assistant Curator in Charge.

Division of Marine Invertebrates: Waldo L. Schmitt, Curator in Charge; C. R. Shoemaker, Assistant Curator; J. O. Maloney, Aid.

Division of Mollusks: Paul Bartsch, Curator in Charge; Harold A. Rehder, Assistant Curator; J. P. E. Morrison, Aid.

Division of Echinoderms: Austin H. Clark, Curator in Charge.

Maintenance is covered under general maintenances for other museum activities.

*Provisions for visiting investigators:* Accredited visiting investigators are given access to the collections in which they are interested under whatever supervision may be required and are afforded facilities for work. No scholarships, fellowships, or tables are maintained.

*Income:* Income is from governmental appropriations for United States National Museum, with assistance in research from the private funds of the Smithsonian Institution, supplemented in some instances by gifts from private individuals for specific purposes.

*Provision for the publication of results:* Publication offered in Bulletin and Proceedings series of United States National Museum, and in Miscellaneous Collections of Smithsonian Institution.

#### Johnson-Smithsonian Deep-Sea Expedition

*History or origin:* Mr. Eldridge R. Johnson in October, 1932, placed his palatial yacht CAROLINE at the disposition of the Smithsonian Institution and offered to finance the necessary equipment for the yacht to render her suitable for marine exploration. The direction of this work was placed in the hands of Dr. Paul Bartsch who outlined a program of exploration of the Atlantic deeps, beginning with the Puerto Rican Deep.

To this end the yacht was provided with a sonic sounding apparatus, a hydrographic winch in a general way corresponding with that on the ATLANTIS, carrying 5,563 feet of Special  $\frac{3}{8}$  inch, 6 x 19 Monitor Strand, hemp center, wire rope. Suitable other equipment for physical, chemical, and biological investigations was also installed.

The first Johnson-Smithsonian Deep-Sea Expedition resulted in a series of soundings and dredging stations. In addition to the soundings, it should be stated that with every dredging station soundings were made at very short intervals, gaining a complete contour of the ground covered during each haul. These have been plotted and will be published in the final report.

In addition to the physical and chemical data, we obtained some 2,000 tubes, jars, and tanks full of specimens, which have been distributed to the various specialists for report.

Plans have been made for the creation of a new winch constructed on entirely new lines, which will carry 15 miles of stranded wire cable, three spools of 5 miles each,  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and  $\frac{3}{4}$  inch. This winch contains specially controlled devices which should prove useful when the instrument used becomes snagged on the bottom.

The first effort is to be followed by others, of which the next one is scheduled to be in the Puerto Rican Deep, completing that research. This began January, 1935.

*Location:* The shore work was conducted at the Smithsonian Institution and its branches. The yacht's home port is Brooklyn, New York.

*Organization to which attached:* Smithsonian Institution.

*Purposes:* Physics, chemistry, and biology of the sea.

*Scope of activities:* Systematic research on collections which include extensive series representing the life of the sea.

*Equipment:* The yacht and the shore facilities of the Smithsonian Institution.

*Staff on the First Cruise:*

Scientists: Director, Paul Bartsch; Parasitologist, E. W. Price; Physicist, Townsend Brown; Manager of equipment, E. R. Fenimore Johnson; Assistant Zoologist, Charles Weber.

Technical and clerical: Artist, Elie Cheverlange; Photographer, G. R. Goergens; Dredging Master, John Mills; Winch Master, W. J. Kennedy; Secretary, Anthony Wilding.

Guests: Mr. and Mrs. Leon Douglass; Miss Ena Douglass; Miss Florence Douglass; Dr. George Derby.

*Provisions for visiting investigators:* Good.

*Income:* Expedition financed personally by Mr. Eldridge R. Johnson.

*Provision for the publication of results:* Smithsonian Miscellaneous collections.

### Marine Division, United States Weather Bureau ('37)

*History or origin:* Origin, as a Government project, goes back to Lieutenant M. F. Maury's justly famous researches and collections of data, beginning 1850, under the United States Navy. The work of collecting and compiling marine meteorological data was kept up by the U. S. Signal Service from 1871 until 1887, when it was transferred to the Hydrographic Office of the Navy, where it remained until 1904. The Marine Division of the Weather Bureau was established to handle the work in 1904, in coöperation with the Hydrographic Office. The Act of June 16, 1910, clarified the field of coöperation between these two offices, in maintaining a program of Government activity in the field of marine meteorology. In 1913 the Marine Division was discontinued, and the work became an adjunct of the Climatological Service until 1920, when the Marine Division was restored. Separate status has since been maintained, until now (1936) there are ten employees on the staff of the Marine Division in Washington, and a variable number of field station employees giving full or part-time to the marine meteorological project.

*Location:* At the Weather Bureau Central Office, 24th and M Streets, N. W., Washington, D. C.

*Organization to which attached:* Weather Bureau, United States Department of Agriculture.

*Purposes:* To foster accurate, uniform and coördinated observation of the weather over the oceans; and to collect, organize, and as far as possible digest the results from such a program of marine meteorological work, for the benefit of commerce, navigation, and science.

*Scope of activities:* Ships of all nationalities are enlisted for coöperative reporting of their weather observations; methods of observation and instrumental equipment are as far as possible supervised, with the object of attaining good standards of accuracy in the results of observation; printed information as to good method, and also carrying summaries of results of the ocean weather program, prepared and disseminated; records are gathered promptly and fully organized and are filed in permanent archives; material from ships' observations is combined with land stations' reports to prepare a continuing series of daily synoptic weather charts for the northern hemisphere which is of the greatest

practical value as a record of atmospheric events affecting commerce and navigation, and also of great value to meteorological science; investigations are conducted in the field of marine meteorology, and results of investigation by other scientific workers are coördinated.

*Equipment:* Adequate office quarters and storage space in Government-owned buildings at Washington, D. C., and at suitable Weather Bureau field stations in the major ports of the United States and its possessions.

*Staff:* Senior Meteorologist, Chief of Division, I. R. Tannehill; Associate Meteorologist, Asst. Chief of Division, W. E. Hurd; Associate Meteorologist, Gardner Emmons; 2 senior scientific aids; 1 scientific aid; 2 assistant scientific aids; 1 senior clerk; 1 assistant clerk.

(Personnel at field stations not specifically assigned to the Marine Division, but coöperating on a flexible basis.)

*Provisions for visiting investigators:* Good provision for individual visiting investigators, but space not available to accommodate visiting workers in groups of more than two or three.

*Income:* Costs covered as a part of Congressional appropriations for the Weather Bureau; no direct income.

*Provision for publication of results:* Monthly summaries of weather conditions over North Atlantic and North Pacific oceans published regularly, and special articles occasionally, in the Monthly Weather Review. Compilations of averages, and special articles and summaries published in the Pilot Charts and in Sailing Directions and Naval Air Pilots of the United States Hydrographic Office.

#### FLORIDA

##### Tortugas Laboratory ('37)

*History or origin:* This laboratory was built upon Loggerhead Key, Tortugas, in June, 1904, the site being occupied under a revocable license from the U. S. Department of Commerce which maintains a lighthouse station on the Key. Work was inaugurated and conducted under the directorship of Doctor Alfred G. Mayor, who died in June, 1922. Since then the Laboratory has been open each summer, with Doctor W. H. Longley in administrative charge, until his death March 10, 1937. Doctor D. H. Tennent is now in charge. Many studies have been undertaken in continua-

tion of previous work, or in direct relation to investigations otherwise supported by the Carnegie Institution of Washington. The site was chosen on account of the purity of the ocean water which surrounds this group of seven small sandy islands, the proximity of the Gulf Stream with its abundant life, the presence of the richest coral reefs of Florida, and the absence of local fisheries. The Laboratory is equipped to afford excellent facilities to competent investigators for the study of many problems of the tropical ocean and its life. Special expeditions have been undertaken to Australia, Samoa, Fiji, Jamaica, Bermuda, Porto Rico, Tobago, and the Bahamas. From 1917 until 1920, four expeditions to study the reefs of Tutuila, American Samoa, were conducted, comprising the first thorough study of any high island of the Pacific in relation to its coral reefs.

*Location:* On Loggerhead Key, The Dry Tortugas, 68 miles west of Key West, Florida.

*Organization to which attached:* Carnegie Institution of Washington, Washington, D. C.

*Purposes:* Research only.

*Scope of activities:* Systematic zoology and botany; experimental studies in ecology, heredity, regeneration and growth; intensive study of geology, botany, zoology, and physiography of coral reefs; chemistry and physics of the tropical ocean with relation to life.

*Equipment:* 1 laboratory building; 1 laboratory building, with annex (serving as aquarium); 1 yacht ANTON DOHRN, 71 ft. long, twin-screw, 100 h.p., equipped to work to a depth of 600 fathoms; 2 launches, VELELLA and DARWIN, 28 ft. long; service buildings, including kitchen, dining-room and machine shop.

*Staff:* Officer in charge, Dr. D. H. Tennent, Bryn Mawr, Pennsylvania.

*Provisions for visiting investigators:* Limited number of investigators chosen for special studies during summer season.

*Income:* Grant of approximately \$14,000 for maintenance and expenses for each season.

*Provision for publication of results:* Twenty-eight volumes of "Papers from the Tortugas Laboratory of the Carnegie Institution of Washington" have so far been published, including 178 papers. The Institution has also published a few special monographs and investigators have issued many reports of their work in appropriate journals.

## MAINE

**University of Maine Marine Laboratory ('37)**

*History or origin:* Started by the Department of Zoology at the University of Maine in 1931.

*Location:* Site of Old Federal Coaling Station, Lamoine, Maine.

*Organization to which attached:* University of Maine.

*Purpose:* The Laboratory opened with the specific purpose of offering good instructional work in Marine Zoology and particularly in Marine Invertebrates.

*Scope of activities:* Offering courses in Marine Invertebrate Zoology.

*Equipment:* 65 acres of ground with two residence buildings, a laboratory building which could accommodate 48 students, equipped with electric lights and running fresh and salt water, row boats, motor boat, and a pier extending 300 feet into the water and with a 400 foot frontage.

*Staff:* Prof. J. W. Murray, other members of the University staff, and visiting instructors.

*Income:* Student tuition, room rental, sale of materials, and appropriation by University of Maine.

*Scope of activities:* Research on marine biology and on tissue culture of normal and cancerous cells.

*Equipment:* Ample equipment for ordinary laboratory work in marine biology, minimum equipment for marine physiology and for biochemistry.

*Staff:* Director, William H. Cole, Rutgers University, New Brunswick, N. J. Technical and clerical: 1. Maintenance and operation: 1.

*Provisions for visiting investigators:* Qualified investigators may work in the laboratory upon payment of \$100 fee for the summer season or \$40 per month. In special cases the fees may be reduced or waived upon application.

*Income:* Sources: Corporation membership dues and assessments. Annual gifts by non-members. No endowment.

Amount: \$12,000 in 1930; \$10,000 in 1931; \$6,500 in 1932; \$4,200 in 1933; \$4,500 in 1934; \$2,900 in 1935; \$4,200 in 1936.

*Provision for publication of results:* Abstracts of researches accomplished are published in the Annual Bulletin (January) which is widely distributed to laboratories and biologists, and which is available on request.

**The Mount Desert Island Biological Laboratory ('37)**

*History or origin:* In 1898 a laboratory was established at South Harpswell, Maine, by J. S. Kingsley of Tufts College. Reorganization of the Laboratory as a scientific corporation under the laws of the State of Maine with a board of ten trustees and J. S. Kingsley as a director, took place in 1913. In 1921 the Laboratory was removed to Salsbury Cove on Mount Desert Island, Maine, and designated the Weir Mitchell Station of the Harpswell Laboratory. In 1923, the Corporation name was changed to Mount Desert Island Biological Laboratory.

*Location:* Salsbury Cove on Mount Desert Island, Maine.

*Organization to which attached:* A private corporation (see above).

*Purposes:* "The purposes of said Corporation," as provided in its certificate of organization, "are to establish and maintain a laboratory or laboratories for biological study and investigation in the State of Maine and to carry on other operations essential to and in furtherance of such aims and purposes, in accordance with the provisions of Sections 1, 2, and 3, of Chapter 57 of the Revised Statutes 1903 of the State of Maine."

## MARYLAND

**Chesapeake Biological Laboratory ('37)**

*History or origin:* Developed from work of a staff member of Department of Zoology, University of Maryland, started in 1920. Broadened out to accommodate a few workers and students in 1927 in temporary building. Present permanent brick structure built in 1930.

*Location:* Solomons Island, Maryland, at the confluence of the Patuxent River and Chesapeake Bay.

*Organization to which attached:* State of Maryland, and governed by: Goucher College, Johns Hopkins University, University of Maryland, Washington College, Western Maryland College, Carnegie Institution of Washington, and the Maryland Conservation Commission.

*Purposes:* Statement from act creating the Laboratory: "To afford a research and study center where facts tending toward a fuller appreciation of nature may be gathered and disseminated."

*Scope of activities:* (a) Hydrography of the Chesapeake Bay region; (b) Problems in experimental biology; (c) Biological survey of the Chesapeake region; (d) Practical problems dealing with conservation of the more economic forms.

*Equipment:* Standard laboratory equipment, including boats, collecting devices, samplers (bottom, plankton, water, etc.), chemical equipment for four specialists, running water both fresh and ocean, constant temperature baths, diving equipment (hood and bentharium), photographic facilities, pier, Weather Bureau station, microscopes, etc.

*Staff:* Director: Dr. R. V. Truitt, University of Maryland.

Marine Ecologist: Dr. C. L. Newcombe, University of Maryland.

Ichthyologist: Dr. Vadim D. Vladikov (Permanent member of staff).

Chemist: Mr. William Horne (Permanent member of staff).

Diatomist: Mr. Paul S. Conger, Carnegie Institution of Washington.

Physiologist: Dr. Norman E. Phillips, University of Maryland.

Secretary: Miss Erma Dixon.

Captain of Craft: Harvey Mister.

On the Executive Committee of the Laboratory are:

Dr. David Robertson, President, Goucher College.  
Dr. H. C. Byrd, President, University of Maryland.

Dr. Gilbert W. Mead, President, Washington College.

Dr. Fred Holloway, President, Western Maryland College.

Dr. R. V. Truitt, Director (*Ex officio*).

*Provision for visiting investigators:* Space available for six or eight investigators.

*Income:* State supported institution with funds that vary from time to time according to problems presented. \$8,500 is appropriated annually for maintenance of Laboratory proper, while coöperating institutions support personnel.

*Provision for publication of results:* As yet, no provision has been made for publication of results though prospects for funds with which to accomplish this end are good.

#### MASSACHUSETTS

##### Department of Oceanography at the Museum of Comparative Zoology ('37)

*History or origin:* The department was organized because of Alexander Agassiz's interest in the sea.

*Location:* Cambridge, Mass.

*Organization to which attached:* Harvard University.

*Purposes:* The care and study of marine collections, instruction in oceanographic research.

*Scope of activities:* The main limitation is the fact that no running salt water is available in the laboratory.

*Equipment:* The very exceptional library of the Museum is the most noteworthy aid to research.

*Staff:* Scientific: Dr. Henry B. Bigelow; C. Iselin.

*Provisions for visiting investigators:* There is limited space for properly qualified investigators and students.

*Income:* The Alexander Agassiz Fellowship in Oceanography and other endowment.

*Provision for publication of results:* The Bulletin of the Museum of Comparative Zoology.

##### North Atlantic Fishery Investigations, Section of the U. S. Bureau of Fisheries ('37)

(Including the U. S. Fisheries Biological Station, Woods Hole, Mass.)

*History or origin:* The North Atlantic Fishery Investigations section was established within the Division of Inquiry Respecting Foods Fishes of the U. S. Bureau of Fisheries in 1929. The U. S. Fisheries Biological Station at Woods Hole was established by the U. S. Commission of Fish and Fisheries in 1881.

*Location:* The investigating staff has laboratory facilities at the Biological Laboratories of Harvard University, Cambridge, Mass., and at the U. S. Fisheries Biological Station, Woods Hole, Mass.

*Organization to which attached:* U. S. Bureau of Fisheries.

*Purposes:* To determine the nature and causes of the fluctuations in abundance of the marine food fishes of the region and to formulate and recommend measures for the perpetuation of the fishery resources.

*Scope of activities:* Marine fisheries research related to the purposes set forth above on the Atlantic coast from Maine to Virginia, and confined mainly to the waters lying within the continental slope. It includes such related subjects as the physics and chemistry of sea water, ocean circulation, production and abundance of plankton, life histories of fish, their migrations, et cetera.

*Equipment:* The Fisheries Biological Station at Woods Hole has a 40 foot motorship for inshore work and a gasoline launch. The laboratory is provided with running sea water, gas, electricity, compressed air, ordinary chemical equipment, aquaria, tanks, and outside enclosures for holding live fish.

*Staff:* Scientific: Oscar E. Sette, In charge, North

Atlantic Fishery Investigations and Director, U. S. Fisheries Biological Station.

William C. Herrington, Biologist, in charge of haddock investigations.

Robert A. Nesbit, Assistant Biologist, in charge of shorefish investigations.

John R. Webster, Jr. Biologist, assisting in haddock investigations.

William C. Neville, Sr. Biological Aid, assisting in shorefish investigations.

F. E. Firth, Assistant Biological Aid, assisting in mackerel investigations.

Technical and clerical: 2.

Maintenance and operation (provided by the hatchery staff at Woods Hole).

*Provisions for visiting investigators:* Laboratory space and facilities are customarily provided for approximately twenty visiting investigators during the summer season at the Fisheries Biological Station. Since the summer of 1931 such provisions have not been made due to shortage of funds.

*Income:* Source: U. S. Governmental appropriations. Amount (exclusive of maintenance of biological station and operation and maintenance of vessels): Fiscal year ending June 30, 1932, \$58,450; fiscal year ending June 30, 1937, \$27,530.

*Provision for publication of results:* Results are published in Bulletins of the Bureau of Fisheries and Reports of the Bureau of Fisheries.

### Woods Hole Oceanographic Institution<sup>2</sup> ('37)

*History or origin:* The Woods Hole Oceanographic Institution, founded in 1930, is a research establishment supported by endowment made by the Rockefeller Foundation, on recommendation of the National Academy. While it is wholly independent in organization, close association with universities and other educational bodies is assured through the personnel of its Board of Trustees.

*Location:* Woods Hole, Massachusetts.

*Organization to which attached:* Independent.

*Purposes:* To encourage and carry on the study of oceanography in all its branches.

*Scope of activities:* (1) Investigations in thermal interchange between the sea surface and the overlying air; (2) hydrology and dynamical oceanography of the western North Atlantic and adjacent waters; (3) chemistry of sea water; (4)

marine bacteriology; (5) zooplankton and phytoplankton; (6) problems in physiology such as those of zooplankton and of respiration; (7) marine sediments. There is active coöperation with United States Coast Guard, United States Coast and Geodetic Survey, United States Hydrographic Office, and various universities.

*Equipment:* 1 laboratory building, 4 floors, 136 x 50 feet.

Through the courtesy of the Marine Biological Laboratory the staff and visitors to the Woods Hole Oceanographic Institution enjoy the full facilities of the former's library, which makes it unnecessary for the Institution to maintain one of its own.

Research ship ATLANTIS is a steel ketch with 280 H.P. Diesel engine designed for a speed under power alone of about eight knots and with a sufficient spread of canvas to sail well. The cruising radius under power alone is about 3,000 miles. Her dimensions are 142 ft. length over all, 29 ft. beam, 17½ ft. extreme draft, about 380 tons displacement.

Gasoline launch ASTERIAS, 40½ ft. long, 12½ ft. broad, draft of 4 ft.; speed, nine knots; living quarters for four men for short cruises.

Row boats are available.

The laboratory has its own dock with ample depth of water for ATLANTIS and a large float for small boats.

An automatic tide-gage was installed in 1932 by the U. S. Coast and Geodetic Survey.

*Staff:* The staff consists of permanent scientific members and of research associates appointed for definite terms. The present personnel (1936) is as follows:

Director, Henry B. Bigelow, Professor of Zoology, Harvard University.

Junior Biologist, George L. Clarke, Tutor and Instructor, Harvard University.

Research Associate in Physical Oceanography, C. O. Iselin, II, Assistant Curator of Oceanography, Museum of Comparative Zoology.

Research Associate in Oceanography, A. E. Parr, Curator of the Bingham Oceanographic Collection, Yale University.

Research Associate in Physical Chemistry, Norris W. Rakestraw, Associate Professor of Chemistry, Brown University.

Senior Biologist, Alfred C. Redfield, Professor of Physiology, Harvard University.

Junior Marine Bacteriologist, C. E. Renn, Harvard University.

<sup>2</sup> Woods Hole Oceanographic Institution, Annual Announcement, fourth year, 1934-35.

Oceanographer, C. G. Rossby, Professor of Meteorology, Massachusetts Institute of Technology.

Investigator in Oceanography, H. R. Seiwell.

Research Associate in Oceanography, Floyd M. Soule, Senior Physical Oceanographer, United States Coast Guard.

Research Associate in Submarine Geology, Henry G. Stetson, Assistant Curator of Paleontology, Museum of Comparative Zoology.

Marine Bacteriologist, Selman A. Waksman, Microbiologist, New Jersey Agricultural Experimental Station.

Research Associate in Physical Oceanography, E. E. Watson, Lecturer in Physics, Queen's University.

Honorary Research Associate in Oceanography, Captain Sir Hubert Wilkins.

Business Manager, William C. Schroeder.

Secretary and Administrative Assistant, Miss Virginia B. Walker.

Superintendent of Buildings and Grounds, William Schroeder.

*Provisions for visiting investigators:* A limited number of visiting investigators, who desire either to collaborate with members of the staff in the regular station program or who are engaged in their own researches in some branch of oceanographic science, can be accommodated.

In special cases facilities are available for visitors to carry out investigations at sea, from ATLANTIS.

No formal course of instruction is offered at the Institution.

*Income:* About \$102,000 annually.

*Provision for the publication of results:* The serial "Papers in Physical Oceanography and Meteorology" supported jointly by the Institution and by the Massachusetts Institute of Technology provides a medium for prompt publication of contributions in these fields. Arrangements are made for publication of investigations in Oceanic Biology and Chemistry in whatever journal may seem most appropriate in each particular instance.

#### NEW HAMPSHIRE

#### Isles of Shoals Marine Zoological Laboratory ('37)

*History or origin:* Established by the Department of Zoology of the University of New Hampshire in the summer of 1928.

*Location:* Isles of Shoals, located about 10 miles off Portsmouth. Laboratory proper is situated on Appledore Island.

*Organization to which attached:* University of New Hampshire, Durham, N. H.

*Purposes:* To offer facilities for minor biological investigations to pre-medical students and undergraduate zoology majors; to offer more advanced work in the field of oceanography and marine ecology to a few select students working for a Master's degree.

*Scope of activities:* Chiefly along the following lines: General invertebrate and vertebrate taxonomy including minor problems and assigned topics for investigation. Comparative anatomy, adapted chiefly for pre-medical students with minor problems assigned to more advanced students. Research work in oceanography and marine ecology.

*Equipment:* Approximately twenty-five acres including practically all of Appledore Island; 5 well-built houses formerly connected with the Appledore Hotel; dining hall fully equipped and operated by the University of New Hampshire; 1 30-foot cabin cruiser; 1 28-foot speed boat; 4 dories; nets, dredges, and other necessary equipment.

*Staff:* Scientific: Director, Dean C. F. Jackson; Director of Instruction, Dr. Norman K. Arnold; Dr. C. D. Williams, Biological Education; Mr. Robert Eadie, Anatomy; Miss Eleanor Sheehan, Invertebrates; Miss Ruth E. Thompson; Additional laboratory assistants; Technical and clerical, 3; Maintenance and operation, 4.

*Provisions for visiting investigators:* No special provisions. Visitors are welcome at all times and will be provided with such facilities as are available.

*Income:* Sources: Regular appropriations from the University of New Hampshire.

Amount: (Difficult to determine since this is an integral part of the Zoology Department of the University of New Hampshire.) For operating expenses, \$3,000.

*Provision for publication of results:* No special provision. Since the primary purpose is to instill the spirit of research into undergraduates and first year graduate students, no special avenue for the publication of results has as yet been provided.

## NEW YORK

**Department of Tropical Research of the New York Zoological Society ('37)**

*History or origin:* The department developed as an outgrowth of the scientific work of the Department of Ornithology of the New York Zoological Society under the direction of Doctor William Beebe. It was established under its present name in January, 1916. Oceanographic work has been stressed since 1925.

*Location:* Permanent Home Laboratory, New York Zoological Park, New York City.

Permanent Field Laboratory, New Nonsuch, St. Georges, Bermuda.

Field Residence, Bermuda Biological Station, to which researches are accredited jointly with the N. Y. Z. S.

Field Stations and Vessels: Arcturus Oceanographic Expedition, 1925 (S. Y. ARCTURUS); Hudson Gorge Expeditions, 1928 (S. T. LIGHT HORSE); Nonsuch Island, Bermuda, 1929, 1930, 1931 (S. T. GLADISFEN); Bermuda Biological Station, 1932, 1933, 1934, 1935 (S. T. FREEDOM, S. T. POWERFUL, S. T. GLADISFEN); Templeton Crocker Expedition, Lower California, 1936 (Y. ZACA).

*Organization to which attached:* New York Zoological Society.

*Purposes:* The purpose of the Department is to provide means for investigating the animal life of the deep sea. In this respect it is the policy of the Department to confine its activities in the main to a limited section of the ocean, instead of undertaking lengthy expeditions with widespread stations. Thus for seven years all work has been confined to the animal life of a circle of ocean eight miles in diameter, situated five miles south of Bermuda.

*Scope of activities:* The scope of activities is confined mainly to the ecological aspects of the oceanic fauna, and particularly the life-histories of deep-sea fish. Observations upon the living organism is especially stressed, and this has given rise to the use of the Diving Helmet and the Bathysphere as means of investigating the life of deep-sea animals. Little attention has been paid to the physical side of oceanography, owing to the intensive work in this field of other institutions.

*Equipment:* The home laboratory is completely equipped with a large library and necessary instruments for the accomplishment of biological research. A considerable amount of this material

is transferred to the field laboratory when it is in operation, and additional field equipment is available for sounding and for dredging, trawling, and tow-netting to depths of three miles. The Bathysphere and its machinery is also used for observations to depths of one half mile.

*Staff:* Scientific: Dr. William Beebe, Director; Mr. John Tee-Van, General Associate; Dr. William K. Gregory, Scientific Associate; Miss Gloria Hollister, Research Associate; Miss Jocelyn Crane, Laboratory Associate.

Technical and clerical: Varies considerably with each expedition; all clerical details are taken care of by the clerical offices of the New York Zoological Society.

*Provisions for visiting investigators:* Varies according to expedition.

*Income:* Source: Donations from private individuals and from the Board of Directors of the Zoological Society.

Amount: Has varied in the past from \$3,000.00 to \$20,000.00, annually, not including the salaries of the staff.

*Provision for publication of results:* All technical publications are published in "Zoologica," the Scientific Contributions of the New York Zoological Society. Less technical matter finds its place in the Bulletin of the Society, as well as many other publications, and in book form.

## NORTH CAROLINA

**United States Fisheries Biological Laboratory ('37)**

*History or origin:* The United States Bureau of Fisheries found its origin in a joint resolution passed by the Senate and House of Representatives in 1871. Beaufort, N. C., was found to be a place especially well suited for the study of the marine fauna and flora. In 1899 the first fisheries laboratory became established in a rented building. In 1900 Congress authorized the erection of a biological station which was completed and opened to investigators for the first time in 1902.

*Location:* Piver's Island, Beaufort, North Carolina.

*Organization to which attached:* Department of Commerce, Bureau of Fisheries, Division of Scientific Inquiry.

*Purposes:* Investigations of marine biology, especially in relation to species of fish and shellfish of commercial importance.

*Scope of activities:* Chief investigations at present dealing with the biology and culture of the oyster and diamond-back terrapin.

*Equipment:* Scientific equipment, boats both motor and rowboats, laboratory, library, mess hall, and dormitory.

*Staff:* Scientific: Director, Dr. Herbert F. Prytherch. Technical and clerical: 1. Maintenance and operation: 5.

*Provisions for visiting investigators:* Dormitory rooms and laboratory facilities.

*Income:* Source: United States Government.  
Amount: \$13,000.

*Provision for publication of results:* United States Government Printing Office.

will have three private rooms and space for twelve investigators in the central room. Visiting investigators will be welcome to utilize available facilities but must provide any special equipment needed.

*Income:* The work will be maintained by annual state appropriation by the state to the college. An appropriation of \$5,000.00 for the coming fiscal year is expected.

*Provision for publication of results:* As yet no provision has been made for publication of results.

## EASTERN SOUTH AMERICA

### RHODE ISLAND

#### Marine Biological Laboratory of Rhode Island State College ('37)

*History or origin:* Made possible by an appropriation of \$8,000.00 in December, 1936, for the construction and equipping of a laboratory for the study of Narragansett Bay and adjacent waters.

*Location:* At Fort Kearney (Old South Ferry). The War Department has granted the use of land and a dock.

*Organization to which attached:* It will function as a division of the Department of Zoology of Rhode Island State College.

*Purposes:* Scientific investigation of marine problems in Rhode Island waters.

*Scope of activities:* There will be no restriction in the scope of the work which can be carried on, so long as it is marine in nature.

At the present time two programs are being carried on: (a) A study of the biology of the zooplankton population. (b) A continuation of an investigation on the biology of the starfish in Narragansett Bay—carried on during the past year under the auspices of the Federal Bureau of Fisheries and the State Department of Fish and Game.

*Equipment:* The laboratory will be fully equipped for oceanographic work in coastal waters. The present appropriation provides \$1,300.00 for field gear and \$810.00 for laboratory equipment. \$850.00 is available for vessel hire (three months).

*Staff:* The staff will consist of a director (Charles J. Fish) and an investigator who will receive a salary. In addition an assistant will be appointed at a salary of \$80.00 per month during the summer period. This staff will be supplemented from time to time by voluntary investigators.

*Provisions for visiting investigators:* The laboratory

Various attempts to procure information on institutions engaged in oceanographic work in the Latin American countries met with very little success. A reply was received only from the Brazilian Serviço de Caça e Pesca and from Mexico. Therefore, for other countries, dependence had to be placed on the Year-Book for 1937 of the International Hydrographic Bureau and such notes as could be found in publications. Apparently there are hydrographic services under the Ministries of War and Marine in Colombia, Cuba, and Venezuela, but, except addresses in the Year-Book above mentioned, no information is available on them.

The article referred to below<sup>3</sup> discusses the provisions for fisheries investigations in the Americas and emphasizes the paucity of such investigations in Latin America. Only three countries are mentioned in this connection, Brazil, Uruguay, and Mexico. A statement on Brazil of later date than Professor Beltrán's article is given on a subsequent page of this catalogue and there is also a note on Argentina. Two paragraphs (p. 12) read as follows:

"En el Uruguay existe establecido un Instituto de Pesca que, dedicado fundamentalmente a investigaciones científicas, se ocupa también de actividades industriales y comerciales, tales como la fabricación de hielo (para establecimientos del Gobierno y venta a particulares) y el arrendamiento de cámaras frigoríficas.

"En México, el autor de este artículo logró establecer, dependiente de la Secretaría de Agricultura y Fomento (Dirección de Estudios Biológicos), la Estación de Biología Marina del Golfo que, bajo su dirección, funcionó en el puerto de Veracruz en los años de 1926-27, siendo descontinuada después por necesidades de carácter económico, cuando prometía los más halagadores frutos de sus actividades."

<sup>3</sup> Beltrán, Enrique, Estudios de biología marina y pesca en las Américas: Unión Panamericana, ser. Fin., Indust., y Comer., Bol. No. 73, pp. 12, Marzo, 1933.

## ARGENTINE

**Servicio Hidrográfico ('37)***Location:* Calle Paraguay, 2137, Buenos-Aires.*Staff:* Hydrographer, Capitán Raul G. Aliaga.

Head of Hydrographic Section, Ingeniero Hidrografo Miguel Rodriguez.

Head of Section of Lights, Teniente de Navio (R) Angel Acevedo.

Head of Naval Observatory, Teniente de Navio (R) Carlos Braida.

Head of Navigation Section, Teniente de Navio (R) Enrique Monti.

Chief of Technical Division, Teniente de Fragata (R) Enrique Monti.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
SAN LUIS.....	640	11	53
SAN JUAN.....	640	2	17
ALFEREZ MACKINLAY.....	800	8	55

**División de Pesca ('34)***Location:* Continuación de la Calle Brasil, Buenos Aires.*Organization to which attached:* Ministerio de Agricultura.*Staff:* Director, Dr. Raul Sorcaburu.

## BRAZIL

**Directoria de Navegação, États-Unis du Brésil ('37)***Location:* Ilha Fiscal, Rio de Janeiro.*Staff:* Director General of Navigation, Vice-Almirante Raúl Tavares.

Head of Division of Administration, Capitão de Fragata Marcelino José Jorge.

Head of Division of Hydrography, Capitão Tenente Ary dos Santos Rongel.

Head of Division of Lights, Capitão de Corveta Carlos Penna Botto.

Head of 1st Section of Division of Hydrography, Capitão Tenente Fernando Saldanha da Gama Frota.

Head of 2nd and 3rd Sections of Division of Hydrography, Capitão Tenente Mario Camara Hoffmann.

Head of 4th Section of Division of Hydrography, Capitão Tenente Paulo Antonio Telles Bardy.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
RIO BRANCO.....	750	7	79
TENENTE LAHMEYER.....	320	2	35
JOSÉ BONIFACIO.....	2,080	8	120

**Serviço de Caça e Pesca (Service of Hunting and Fishing)<sup>4</sup> ('35)**

*History:* In 1912 an attempt was made to establish a Directorate of Hunting and Fishing in the Ministry of Agriculture but the endeavor was not successful. In 1923 the service was placed under the Ministry of the Marine and made subordinate to the Directorate of the Merchant Marine. This arrangement for various and obvious reasons was unsatisfactory. As a result of further consideration of the subject, by a decree of March 8, 1933, a Serviço de Caça e Pesca was established under the National Department of Animal Production of the Ministry of Agriculture.

*Location:* Rio de Janeiro.

*Organization to which attached:* As stated above, Ministry of Agriculture, National Department of Animal Production. There is a Conselho de Caça e Pesca (Council of Hunting and Fishing) composed as follows: One representative of Serviço de Caça e Pesca, one representative of fishermen, one representative of hunters, one representative of vessels engaged in transporting fish, one representative of the Navy, one representative of the National Museum, four members representing special subjects.

*Purposes and scope of activities:* There are under the Service three sections:

1. Secção de Criação (Section of Propagation). This section has charge of pisciculture, of rearing molluscs, and of parks for game refuges.

2. Secção de Investigações (Section of Investigations). The functions of this section are to study the biology of forest animals, hydrobiology, biochemistry, plankton including micro-plankton, the nutrition of fishes; to promote studies of the technology of fishes and of their preservation and of their subproducts. It has charge of zoological parks and aquaria, and of public instruction, particularly of hunters and fishermen.

3. Secção de Indústrias (Section of Industries). Besides superintending the enforcement of the laws governing hunting and fishing and studying various economic problems, it has as its duties the study and application of modern processes of

<sup>4</sup> The statement regarding this service is based upon two publications as follows:

Código de Caça e Pesca (approved pelo decreto No. 23, 672, de 2 de Janeiro de 1934), Min. da Agricult., Depart. Nac. da Prod. Anim., Serv. de Caça e Pesca, Rio de Janeiro, 1934.

Actividades do Serviço de Caça e Pesca de Março de 1933 a Março de 1934, *Ibid.*, 1934.

preserving fish, and the study and application of processes for utilizing fish products, such as oil, meal, condiments, cakes, etc.

The Service has a museum, and it offers instruction in several subjects, including navigation.

For the preparation of bathymetric charts and oceanographic studies, the Service has an arrangement with the Ministry of Marine.

*Equipment:* There is an aquarium and laboratories but no information on them is available.

*Staff:* Director: Dr. João Moreira da Rocha; Ascanio Faria; Genneville Hermsdorff. Full information on the staff is not available.

*Income:* From the State. Amount not known.

*Provisions for publication of results:* Besides special publications, such as those cited at the beginning of this statement, the Service publishes papers in the *Revista do Departamento Nacional da Produção Animal*.

#### URUGUAY

##### Instituto de Pesca<sup>5</sup> ('32)

*Location:* Uruguay 868, Montevideo.

<sup>5</sup> Carlevaro, Rómulo, *El Instituto de Pesca del Uruguay, sus orientaciones, su actividad, sus perspectivas*, Consejo Oceanográfico Ibero-Americano Revista, Año 3, No. 1, pp. 39-43, Feb.; 1932; *Ibid.*, No. 2 pp. 88-89.

*Equipment:* A fisheries station within the city limits of Montevideo.

*Staff:* Director, Dr. Rómulo Carlevaro.

##### Servicio Hidrográfico de la Marina (Hydrographic Office of the Navy) ('37)

*Location:* Sarandi 122, Montevideo.

*Staff:* Head of Service and Inspector of Navigation, Capitán de Fragata Agrimensor Hector Luisi. Head of Section A: Secretariat, Detail and Administration, Capitán de Corbeta Julio A. Cigliutti.

Head of Section B: Astronomy and Navigation, Capitán de Corbeta Bervano Bianchi.

Head of Section C: Hydrography, Capitán de Fragata Julio F. Lamarthée.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
CAPITÁN MIRANDA.....	527	10	38

# INSTITUTIONS, EAST SIDE OF THE PACIFIC OCEAN

## CANADA

### Pacific Biological Station ('37)

*History or origin:* Established in 1908.

*Location:* Nanaimo, east coast of Vancouver Island, British Columbia.

*Organization to which attached:* Biological Board of Canada.

*Purposes:* Research.

*Scope of activities:* Scientific investigation of marine and fresh-water resources.

*Equipment:* 2 laboratories, biological and chemical, with general equipment; 1 library; 1 60-foot motor boat equipped for oceanographical investigations; several smaller boats.

*Staff:* Scientific: Dr. W. A. Clemens, Director.

Dr. R. E. Foerster, Chief Biologist, in charge of sockeye salmon propagation investigations.

Dr. J. L. Hart, Associate biologist for pilchard-herring investigations.

Dr. A. L. Pritchard, Assistant biologist for salmon investigations.

Dr. C. R. Elsey, Assistant biologist for shellfish investigations.

Dr. C. M. Mottley, Scientific assistant for trout investigations.

Dr. A. L. Tester, Scientific assistant in herring investigations.

Dr. W. E. Ricker, Scientific assistant in salmon investigations.

Mr. J. P. Tully, Scientific assistant for oceanographical and general chemical investigations.

Seasonal: 5 to 6 appointments.

Technical and clerical: 3 appointments.

Maintenance and operation: 8 appointments.

*Provisions for visiting investigators:* Accommodation provided during the summer for 10 to 15 members of the staff and post-graduate students of Canadian Universities.

*Income:* Source: Grant from the Government of the Dominion of Canada.

Amount: Approximately \$50,000.

*Provision for the publication of results:* (a) Journal of the Biological Board of Canada; (b) Bulletins—Biological Board of Canada.

### Pacific Fisheries Experimental Station ('37)

*History or origin:* Established in 1926.

*Location:* Prince Rupert, British Columbia.

*Organization to which attached:* Biological Board of Canada.

*Purposes:* Research and source of information on marine products for fishing and allied industries.

*Scope of activities:* Scientific investigation of the handling, curing, manufacture, and utilization of marine products and by-products.

*Equipment:* 2 buildings containing chemical, biochemical, bacteriological, and low-temperature research laboratories, all well-equipped; 2 libraries.

*Staff:* Director, Dr. N. M. Carter.

Dr. H. N. Brocklesby, Associate chemist for fish oil investigations.

Mr. R. H. Bedford, Associate bacteriologist.

Mr. O. F. Denstedt, Assistant chemist (on leave of absence 1936-37).

Dr. L. I. Pugsley, Assistant biochemist in vitamin investigations (temporary).

Dr. W. A. Riddell, Assistant chemist in investigation of fishery products.

Mr. O. C. Young, Assistant research engineer for refrigeration investigations.

Mr. B. E. Bailey, Scientific assistant in biochemical investigations (on leave of absence, 1937).

Seasonal: 1 to 2 appointments.

Technical and clerical: 4 appointments.

Maintenance and operation: 2 appointments.

*Provisions for visiting investigators:* Accommodation for one or two temporary assistants under special circumstances.

*Income:* Source: Grant from the Government of the Dominion of Canada.

Amount: \$30,000 to \$35,000 per annum.

*Provision for the publication of results:*

Journal of the Biological Board of Canada (scientific).

Bulletins of the Biological Board of Canada (semi-technical).

Progress Reports of Pacific Stations of Biological Board of Canada (popular).

Coöperative facilities for publication in Canadian Journal of Research.

## UNITED STATES

## CALIFORNIA

**Kerckhoff Marine Laboratory ('37)**

*History or origin:* Purchased in 1931 with funds furnished by Mr. William G. Kerckhoff. Officially opened in September, 1932.

*Location:* Near the entrance, on the east side of Newport Bay, California. Postoffice address: Corona Del Mar, California.

*Organization to which attached:* California Institute of Technology, Pasadena, California, under the Department of Biological Sciences.

*Purposes:* Research, mainly to supplement that done at the Institute.

*Scope of activities:* Experimental embryology, physiology, marine ecology, biophysics, chemistry. A few of the more advanced undergraduate students and graduate students who are able to work more or less independently.

*Equipment:* Two-story, concrete, Spanish type building. Three large main laboratories, five small laboratory rooms, dark room, boat room, and shop. Salt water system and aquaria. 24-ft. motor boat with dredging equipment.

*Staff:* Dr. T. H. Morgan, Head of the Department of Biology; G. E. MacGinitie, Asst. Professor of Biology, Director; Members of the staff, California Institute of Technology.

*Provisions for visiting investigators:* Some investigators can be accommodated.

*Income:* Provided from the general research funds of the Department of Biology.

*Provision for the publication of results:* The results of researches are published in appropriate scientific periodicals.

**Pomona College Marine Laboratory and Summer School ('37)**

*History or origin:* Summer courses under C. F. Baker, 1911-1913. Building erected 1913 and work under W. A. Hilton, 1913 to present.

*Location:* Laguna Beach, Orange County, California, on the Coast Boulevard.

*Organization to which attached:* Pomona College.

*Purposes:* Summer school for undergraduates and a few graduates, usually six weeks.

*Scope of activities:* Teaching undergraduates; exploration of littoral fauna; work with a few graduates along biological lines.

*Equipment:* 1 frame building, with several private rooms and three general laboratories. Equipment for limited field work and for laboratory work.

*Staff:* Director, Prof. W. A. Hilton; different teachers from other institutions.

*Provisions for visiting investigators:* Private rooms for visitors.

*Income:* The only income is from tuition or rental of research rooms. From \$1,000 to \$2,000, most of which goes for salaries.

*Provision for the publication of results:* Journal of Entomology and Zoology and other journals.

**Scripps Institution of Oceanography ('37)**

*History or origin:* The Scripps Institution grew out of an endeavor begun in 1891 by Dr. William E. Ritter to find a suitable place for the establishment of a marine biological station in connection with the Department of Zoology of the University of California. These efforts resulted in the erection of a marine biological station about 2½ miles north of the village of La Jolla through funds contributed by Miss Ellen B. Scripps and Mr. E. W. Scripps. The first building, the "George H. Scripps Memorial Marine Biological Laboratory," was erected in 1909, and funds for a boat, the ALEXANDER AGASSIZ, and its equipment were donated by Miss Scripps and Mr. Scripps. In 1912 the laboratory was taken over by the University of California under the name of the "Scripps Institution for Biological Research." In 1916 the museum-library building and the Institution's pier were erected. Before Doctor Ritter retired from the directorship of the Institution, it was decided by the administrative officers of the University of California and members of the Scripps family to convert the "Scripps Institution for Biological Research" into one for oceanographic research. Dr. T. Wayland Vaughan assumed the directorship on the first of February, 1924, and the name of the Institution was changed to "Scripps Institution of Oceanography," in October, 1925. The Institution acquired the boat SCRIPPS, which on November 13, 1936, was destroyed by explosion and fire. An additional and larger laboratory, "Ritter Hall," was erected in 1931, and extensive improvements were made in the first laboratory building, in the library, and on the grounds. In the spring of 1937, Mr. R. P. Scripps purchased a larger vessel for the Institution (see "Equipment" below). The regular income of the Institution was increased from about \$44,000 per year in 1924 to about \$90,000 in 1936. On

September 1, 1936, Doctor Vaughan was succeeded as Director by Dr. H. U. Sverdrup.

*Location:* On the sea front, about  $2\frac{1}{2}$  miles north of the center of the village of La Jolla, and about 16 miles north of the city of San Diego.

*Organization to which attached:* University of California, of which the Institution is a department.

*Purposes:* Major, research; also, general instruction in oceanography, and special instruction in different fields.

*Scope of activities:* Research and instruction in dynamical oceanography and marine meteorology; chemistry of sea water; biology, under which bacteriology, phyto- and zooplankton, foraminifera, biology of fishes, and physiology of marine organisms with reference to their environment, are included; marine bottom deposits.

*Equipment:* The laboratory facilities provide for researches of all kinds indicated by the "scope of activities" and the specialties of the members of the staff. In Ritter Hall there are three constant temperature rooms.

1 laboratory building (Geo. H. Scripps Laboratory), 2 floors, 75 x 48 ft.

1 laboratory building (Ritter Hall), 3 floors, 100 x 46 ft.

1 museum-library building, 2 floors and about a  $\frac{3}{4}$  basement, 60 x 60 ft.

Library, more than 14,500 volumes, 30,000 reprints.

1 wooden aquarium building, 24 x 48 ft., 18 tanks.

1 re-enforced concrete pier, 1,000 ft. long, 20 ft. wide (permanent tidal, hydrographic, and meteorological station).

1 re-enforced concrete salt-water storage tank, capacity 60,000 gallons.

24 wooden cottage residences.

Several service buildings and garages (temporary structures).

Automatic tide-gage installed at the end of the Institution's pier by U. S. Coast and Geodetic Survey.

Anderson-Wood seismograph installed in the basement of the Museum-Library building by the Carnegie Institution's Committee on Seismology.

1 research vessel, M. F. MAURY, recently purchased through the generosity of Mr. R. P. Scripps, a schooner 104 feet long, length on the water line 86 feet, beam 20.5 feet, equipped

with a Winton diesel engine of 175 h.p., and under power has a speed of nine knots per hour. The boat is equipped for any of the usual kinds of oceanographic work and can make voyages of any desired length.

Besides utilizing its own facilities for research the Institution receives assistance from the United States Navy, the United States Coast and Geodetic Survey, the United States Bureau of Lighthouses, the California Fish and Game Commission, a number of commercial shipping companies, and other organizations.

*Staff:* Dr. Harald U. Sverdrup, Director (physical oceanography, meteorology).

Dr. F. B. Sumner (biology of fishes).

Dr. G. F. McEwen (physical oceanography, meteorology).

Prof. W. E. Allen (phytoplankton).

Dr. E. G. Moberg (chemical oceanography).

Dr. D. L. Fox (physiology of marine organisms).

Dr. M. W. Johnson (zooplankton).

Dr. C. E. ZoBell (marine microbiology).

Dr. R. H. Fleming (physical and chemical oceanography).

Dr. Roger Revelle (physical oceanography and marine bottom deposits).

Dr. E. E. Cupp (phytoplankton).

Mr. P. S. Barnhart (fishes), Curator of biological collections.

Mr. S. W. Chambers, Associate in physical oceanography.

Research assistants, number variable.

5 technical and clerical assistants.

6 maintenance and operation workers.

*Provisions for visiting investigators:* Between 20 and 25, in addition to the Institution's staff, can be accommodated.

*Income:* Regular annual, nearly \$95,000, about one-half from the State of California and one-half from the Scripps family. In addition, special contributions of variable amount.

*Provisions for publication:* The University of California publishes a series entitled, "Bulletin of the Scripps Institution of Oceanography of the University of California, Technical Series," of which three volumes have been published, and for which a number of other papers have been submitted. The members of the staff also publish papers in various scientific periodicals.

### **Marine Biological Station, University of Southern California ('37)**

*Location:* Since the burning of the Marine Station building in 1921, the station has been located at University Park, and since 1928 when a new Science Building was completed has been housed in especially prepared rooms on the fourth floor of that building. This is some twelve miles from the sea-coast, and located just off the Exposition Park area.

*Organization to which attached:* The Marine Station and its facilities are maintained as an integral part of the Department of Biology at the University of Southern California.

*Purposes:* Major purpose—research.

Courses are offered on the graduate level in marine plant biology, marine survey, animal biology, and marine research. These courses assume major work in the fields of either Zoology or Botany.

*Scope of activities:* Since its establishment in 1911 trawling and dredging work has been carried on almost continuously with emphasis upon ecological relationships of marine forms in the southern California waters. Some investigations have been on the classification of fishes, the study of plankton, foraminifera, and physiological relationships of marine organisms. Certain phases of oceanography have been in progress in later years with an attempt to gather some data on the temperature fluctuations and variations in the physico-chemical composition of the sea water.

*Equipment:* Laboratory facilities on the fourth floor of the new Science Hall include: Office space for the permanent members of the staff; small research rooms for independent investigation, together with several cubicles for graduate students under supervision; a small library; desks equipped with gas, electricity, compressed air; a closed system of sea water aquaria of about 500 gallons capacity; a large preparation room for preserving and taking care of marine collections; ample space and locker material for filing materials in proper phylogenetic order.

*Staff:* Director, Dr. Francis M. Baldwin.

Full-time members of the teaching staff, Departments of Botany and Zoology, University of Southern California, who contribute to investigation and direction of research work as time permits.

Part-time: skipper of the launch, first mate.

*Provisions for visiting investigators:* Not more than

10 at a time, limited to trained investigators working on their own problems, or under the guidance of resident members of the staff.

*Income:* Funds from the University of California.

*Provisions for the publication of results:* None reported.

### **Hopkins Marine Station of Stanford University ('37)**

*History or origin:* Four names are inseparably associated with the founding of the Hopkins Seaside Laboratory in 1892: Timothy Hopkins, David Starr Jordan, Charles Henry Gilbert, Oliver Peebles Jenkins. Back of the obvious desirability of a marine biological laboratory in connection with a new university of great promise was the example of Anton Dohrn's Naples laboratory which had greatly impressed Mr. Hopkins, and the Penikese experiment of Louis Agassiz in which Dr. Jordan played a part at a formative stage of his career.

After a careful examination of various sites along the coast, Pacific Grove, upon the southern side of Monterey Bay, was selected as combining the most desirable features. Through the generous coöperation of Mr. Timothy Hopkins and the Pacific Improvement Company a suitable site and a sum of money sufficient to erect the first building were donated. A plain two-story frame structure, twenty-five by sixty feet in ground dimensions, was erected on Point Aulon, a low rocky headland, and the first session of the new laboratory was held during the summer of 1892. In recognition of the active interest and generosity of Mr. Hopkins, the station was named the Hopkins Seaside Laboratory. Funds for the purchase of books and equipment were furnished by Mr. Hopkins from time to time, and in 1893 he erected a second building to provide more adequately for the needs of the growing institution.

During the first twenty-five years of its existence the laboratory, while nominally a part of the University, and freely using its library and apparatus, was dependent for its upkeep and extension chiefly upon student fees and private gifts, the latter mainly through the constant sympathetic interest of Mr. Hopkins. Despite these limitations it offered its facilities to many investigators and yearly to many students, and contributed materially to the solution of biological problems on the Pacific Coast.

With the passing years it became increasingly

evident that the site upon Point Aulon was inadequate to the needs of the laboratories.

In 1916 an exchange was effected with the Pacific Improvement Company through which a new location was secured, nearly five acres in extent and consisting of the main portion of Cabrillo Point, situated a half-mile eastward of the old site. To this, two and one-half acres were added by purchase in 1921, and about three and one-half acres in 1923. The new situation insures complete control of the coast line of the point, including a sheltered landing-place and harbor for boats of considerable size, and provides room for future expansion. Upon this site the first building of the new Station was erected during 1917.

In recognition of the aid rendered by Mr. Hopkins during the whole life of the laboratory, the Board of Trustees of the University changed the name, October 26, 1917, to the Hopkins Marine Station of Stanford University.

The construction of a second unit of the Station, known as the Jacques Loeb Laboratory, was completed in July, 1928.

After the construction of the Jacques Loeb Laboratory, devoted to experimental biology, it became necessary to designate the original building. Accordingly, in January 1929, the Board of Trustees of the University named it the Alexander Agassiz Laboratory, in honor of America's leading oceanographer.<sup>1</sup>

*Location:* On southern shore of Monterey Bay, California (within corporate limits of town of Pacific Grove).

*Organization to which attached:* Stanford University, of which the Institution is a department.

*Purposes:* Research in biology and oceanography. Instruction: undergraduate courses and graduate work in comparative zoology, comparative embryology, comparative physiology, microbiology, experimental biology, physico-chemical biology, physiology of marine plants, morphology of marine plants, oceanography, shore ecology.

*Scope of activities:* Researches in dynamical oceanography, chemistry of sea water; oceanic biology (ecology); shore ecology; comparative marine zoology (including invertebrates and fishes); embryology of marine organisms; experimental embryology; protoplasm; microbiology; physi-

ology of marine organisms; physico-chemical problems in marine biology (restricted fields); marine algae.

*Equipment:* 1 laboratory building (Alexander Agassiz Laboratory) of three floors, 40 x 80 feet.

1 laboratory building (Jacques Loeb Laboratory) consisting of a two-story central portion with two flanking wings of one story, enclosing three sides of a court, the over-all dimensions, 95 x 152 feet.

1 marine shop and boiler house; one janitor's cottage.

In cooperation with the California State Fish and Game Commission, the use of one of three different sea-going boats for oceanographic work.

Small library and loan service on Stanford Library.

*Staff:* Director, Dr. W. K. Fisher, Zoologist.

Associate Director, Dr. C. V. Taylor, Biologist.

Prof. L. R. Blinks, Plant Physiologist.

Prof. G. M. Smith, Botanist.

Prof. C. B. van Niel, Microbiologist.

Prof. Tage Skogsberg, Marine Biologist, Oceanographer.

Prof. D. M. Whitaker, Biologist.

Prof. F. W. Weymouth, Physiologist.

Dr. R. L. Bolin, Ichthyologist, Ecologist.

Prof. A. R. Moore, Lecturer, Physiologist.

Dr. Austin Phelps, Microbiologist, Oceanographer.

1 research assistant (varies 1-3).

Clerical and technical assistants: 4.

Visiting members from Stanford and one from University of Oregon: 3-4.

*Provision for visiting investigators:* About 10 can be accommodated in addition to visiting members of the staff, the number depending on the nature of the research.

*Income:* Regular for year 1936-37, \$26,500.00.

*Provisions for the publication of results:* None.

#### California State Fisheries Laboratory ('37)

*History or origin:* Established in 1917.

*Location:* On Terminal Island, near San Pedro, Los Angeles County, Calif.

*Organization to which attached:* Bureau of Commercial Fisheries, Division of Fish and Game of California, Department of Natural Resources.

*Purposes:* Research for the Bureau of Commercial Fisheries.

*Scope of activities:* Research in the abundance and changes in the supply of fishes used commercially and the marine fishes caught by sportsmen;

<sup>1</sup> The foregoing information has been abstracted from "General Statement" regarding the Hopkins Marine Station published by Stanford University.

condition of the fisheries; life histories of the species; catch statistics for both commercial and marine sport species with other compilations of fish and game data for the State; effects of legislation and proposal of needed protective measures; various coöperative enterprises with Stanford University, University of California, and other agencies.

*Equipment:* Two laboratory buildings, each of two stories; library. Half-time use of two patrol boats, 85 and 60 feet in length.

*Staff:* W. L. Scofield, Supervisor.

Frances N. Clark, Senior Fisheries Researcher.

G. Houghton Clark, Senior Fisheries Researcher.

Geraldine Conner, Fisheries Statistician.

Richard S. Croker, Senior Fisheries Researcher.

Donald H. Fry, Jr., Senior Fisheries Researcher.

Harry C. Godsil, Senior Fisheries Researcher.

S. Ross Hatton, Junior Fisheries Researcher.

John F. Janssen, Jr., Junior Fisheries Researcher.

Julius B. Phillips, Senior Fisheries Researcher.

Phil M. Roedel, Junior Fisheries Researcher.

Richard B. Tibby, Junior Fisheries Researcher.

10 clerical.

Part time use of patrol officers, varying from 6 to 20.

*Provisions for visiting investigators:* Accommodation for 3.

*Income:* Expenditures of laboratory alone are about \$40,000.00, exclusive of patrol boat maintenance, statistical and printing costs, and other expenditures cared for by administrative and patrol branches of the Bureau of Commercial Fisheries. The Division of Fish and Game is self-supporting, financed from fisheries privilege tax, licenses and fees.

*Provision for the publication of results:* Two publications of the California Division of Fish and Game: (1) a series of "Fish Bulletins", and (2) a quarterly magazine, "California Fish and Game"; and occasional articles in other journals.

#### OREGON

##### Coos Bay Marine Station ('37)

(In process of organization)

*Location:* Located on a projecting promontory at the mouth of Coos Bay inlet on the land assigned to the University of Oregon as a location for such station by a special act of Congress setting aside a certain portion, about eighty acres, of a military reserve held by the government for a number of years. The site is adjacent to the open sea on

one side and the still water of Coos Bay on the other. Along the ocean side of the promontory are extensive reefs replete with marine life and other material for the study of scientific aspects of the subject.

*Organization to which attached:* The station will be attached to the University of Oregon, the University of Oregon Medical School, and the Oregon State Agricultural College. It will be under the direct supervision of a joint board of the Oregon State System of Higher Education.

*Purposes:* The major purpose will be to facilitate research on all scientific aspects of marine phenomena. With the function of research, however, will be combined instruction in various sciences, especially during summer session.

*Scope of activities:* The activities will extend to all phases of scientific investigations which concern themselves with marine biology either in the field of plant life or animal life. Opportunities will be given for research in geology and geography, shore life, paleobotany, and the study of marine organisms with reference especially to an understanding of the type of marine life in the Central Oregon coast region.

*Equipment:* It is impossible to describe the equipment at the present time since only tentative plans have been made for the projected plan. The present plan contemplates a construction of a central laboratory building and adjacent residences, heating plant, and other structures necessary for carrying on the work.

*Staff:* Since the work of the marine station has not been organized, it is impossible to describe the staff which will be used in connection with the operation of the plant and the residence research work which is intended for the station.

*Provisions for visiting investigations:* Provision will be made for a limited number of scientific investigators in all the fields of scientific study represented, special preference being given to the colleges of Oregon, to research workers connected with the Medical School, and the University of Oregon staff.

*Income:* It is impossible to say at present what the income for the station will be. An attempt will be made to combine appropriation from state revenues together with some contributions for the maintenance and operation of the plant. The budget of the State System of Higher Education will contain an item, it is assumed, adequate for the maintenance and operation.

## WASHINGTON

**United States Fisheries Biological Station,  
Seattle, Washington ('37)**

*History or origin:* The first work was carried on in 1925 in Fisheries Hall No. 4, University of Washington. In May, 1931, the present building was finished and the work was transferred there. Three divisions of the Bureau of Fisheries have quarters there: (1) Division of Scientific Inquiry; (2) Division of Fisheries Industry; and (3) Division of Fish Culture.

*Location:* 2725 Montlake Blvd., in the City of Seattle on the shore of Lake Union, about one-half mile from the University of Washington campus.

*Organization to which attached:* United States Department of Commerce, Bureau of Fisheries.

*Purpose:* Research, and administration of the western states by the Division of Fish Culture.

*Scope of activities:* Research on life history, fluctuations in abundance and general biology of fishes; all of the above studies being directed toward the end of discovering facts of importance in the conservation of the fisheries of the Pacific Coast; also chemical and bacteriological research connected with the packing and preserving of fish, the use of fish oils, fishery by-products, and the improvement and preservation of fishing gear.

*Equipment:* One laboratory building, 3 floors, 128 x 50 feet; Library opened October 1, 1931, with about 350 volumes and 600 reprints.

*Staff:* Division of Scientific Inquiry, Dr. F. A. Davidson, in charge; 7 in charge of principal investigations, 6 assistants.

Division of Fisheries Industry, Roger Harrison, in charge, staff of two.

Division of Fish Culture, Fred. J. Foster in charge.

*Provisions for visiting investigators:* None except through special permission of the Commissioner of Fisheries.

*Income:* Division of Scientific Inquiry, \$58,065; Division of Fisheries Industry, \$10,000; Division of Fish Culture, cooperating with Fisheries Industry on fish diseases and with the University of Washington.

*Provision for the publication of results:* Report and appendixes of the Commissioner of Fisheries; Bulletin of the Bureau of Fisheries; Investigational Report of Bureau of Fisheries; Fishery Circulars; and Progressive Fish Culturist.

**Washington State Department of Fisheries,  
Division of Biological Research ('37)**

*History or origin:* June 1, 1935, due to Washington State Planning Council securing funds.

*Location:* Fisheries Hall No. 2, University of Washington, Seattle, Washington.

*Purpose:* Research for regulation.

*Scope:* Research on all food and shell fish, habits, statistics, supply.

*Staff:* Loyd Royal in charge; 6 in charge of separate problems; 1 assistant.

*Income:* \$25,000.

*Provision for the publication of results:* Biological Reports, 1935.

**Biological Department, of Department of Game,  
State of Washington ('37)**

*History or origin:* Made a department in April, 1936.

*Location:* University of Washington, Fisheries Hall No. 2, Seattle, Washington.

*Purpose:* Research on hatchery diseases and foods of trout, etc., biological surveys; stream pollution; fish ways; irrigation by-passes.

*Staff:* Two.

*Income:* Salaries, \$5,000.

*Provision for publication of results:* Publication on biological work, title "Washington Hatcheryman" will appear in April of this year.

**Oceanographic Laboratories, University of  
Washington ('37)**

*History or origin:* Upon recommendation of Dr. M. Lyle Spencer who was then president of the University, the Laboratories were created by the Board of Regents in March, 1930. The Laboratories are composed of three integral parts, (a) the main laboratories on the campus of the University in Seattle, located on the shore of Lake Union; (b) the research ship CATALYST; (c) the field laboratories in the San Juan Islands.

The field laboratories were founded as a biological station in 1904 by Professor Trevor Kincaid, professor of zoology at the University of Washington. The present site of the field laboratories was deeded to the University by Act of Congress in 1920, and much of the present physical plant was constructed under the supervision of Professor T. C. Frye, professor of botany and director of the Biological Station. Since these laboratories became part of the Oceanographic Laboratories, many additions and improvements have been

made and the scientific equipment considerably augmented.

*Location:* (a) University of Washington campus; on shore of Lake Union; ready access to the sea via Lake Washington ship canal.

(b) On the sea shore at Friday Harbor, San Juan Archipelago, about 80 miles north of Seattle.

*Organization to which attached:* University of Washington.

*Purposes:* Major purpose, research. Instruction is given in different phases of oceanography as affecting the several departments of science.

*Scope of activities:* Physical oceanography, oceanographical chemistry, phytoplankton, zooplankton, marine plant physiology, embryology, and marine invertebrates, marine bacteriology, bio-chemistry, and meteorology.

Regions studied,—coastal waters of Washington north of the Columbia River, Puget Sound, Gulf of Alaska, together with the many estuaries and passages of Alaska, the waters of the North Pacific, and Bering Sea.

The staff of the Oceanographic Laboratories is composed of members from the departments of physics, chemistry, bacteriology, botany, and zoology. Candidates for graduate degrees qualify as majors in one of the five fundamental sciences,—thesis and research work being in some phase of their science as affecting oceanography.

*Equipment:* (a) One laboratory building, three floors, 134 x 61 feet, University of Washington. Building equipped with circulating sea water system and provided with most up-to-date laboratory furniture and equipment.

(b) At Friday Harbor, one chemistry laboratory, one floor, 66 x 30 feet; two zoology laboratories, each one floor, 24 x 56 feet; one physics laboratory, one floor, 73 x 30 feet; one botany laboratory, one floor, 67 x 24 feet; one bacteriology and bio-chemistry laboratory, one floor, 56 x 24 feet; one stock room, one floor, 56 x 24 feet; one observation platform for securing data throughout the year; one dock with floats amply supplied with live boxes. Buildings of hollow tile and stucco construction equipped with running fresh water and sea water and electricity. Four of the buildings are equipped with gas.

(c) Research boat CATALYST was put into commission on June 11, 1932. The dimensions are: Length, 75 feet and beam 18 feet, with a draft of 9 feet and gross tonnage of 92 tons. The hull is of heavy construction and designed to

eliminate motor vibration. The keel is of Douglas fir, the frame of oak and double planking of Alaska yellow cedar. On the keel and for two feet at the water level, the boat is sheathed with ironbark. The boat is driven by a Diesel engine of 120 horsepower and has a cruising radius of 3500 miles. Beside the usual pilot house equipment, the CATALYST is equipped with a sonic depth finder and a photoelectric pilot. It is equipped with 4500 meters of  $\frac{5}{16}$ -inch stainless steel cable for taking plankton and water samples and 600 meters of  $\frac{1}{2}$ -inch galvanized cable used in bottom dredging. Throughout the boat, there are sleeping accommodations for sixteen persons.

The laboratory which is on the main deck, is 19 feet long and 10 feet wide, and has working space for seven people. Each of the seven sections is equipped with 110 A.C., and D.C. and one variable voltage outlet, one outlet for Flamo gas, and one duriron drain. The laboratory is also equipped with compressed air outlets and a fume hood with forced ventilation.

*Staff:* Director, Dr. Thomas G. Thompson.

Botany: Dr. George R. Rigg, plant physiology; Dr. Lyman D. Phifer, Phytoplankton.

Chemistry: Dr. Thomas G. Thompson; Dr. Rex J. Robinson.

Physis: Dr. C. L. Utterback.

Zoology: Dr. John E. Guberlet; Dr. Robert C. Migler.

Bacteriology: Dr. B. S. Henry.

Bio-chemistry: Dr. Earl R. Norris.

1 curator, 1 librarian, 1 secretary; 4 maintenance and operation; 6 teaching fellows; 2 stock-keepers.

Research Associates: Dr. Dora P. Henry, zoology; Dr. Belle A. Stevens, zoology.

Besides the regular members of the staff, various members of the science faculties are interested in certain phases of oceanographic research, and the facilities of the laboratories are placed at their disposal.

Commander F. A. Zeusler and Commander Edward H. Smith of the Coast Guard are affiliated with the Laboratories as Lecturers in Oceanography.

*Provisions for visiting investigators:* The Seattle laboratories will accommodate approximately 75 students and investigators. The equipment and facilities of the laboratories are available for visiting investigators.

The Friday Harbor laboratories will accommo-

date about 175 persons, including students, staff members, and visiting investigators.

*Income:* For the initial cost of the research boat CATALYST and the Seattle laboratories and their scientific equipment, the Rockefeller Foundation contributed \$45,000 for the former together with an additional \$20,000 for the operation of the boat, and \$200,000 for the latter. The State of Washington appropriated \$50,000 for the construction and equipment of the laboratories. The entire plant is now operated and maintained by the University of Washington. The University appropriated \$10,000 for the enrichment of the main library for literature pertaining to oceanography.

*Provision for the publication of results:* Investigators of the laboratories are encouraged to publish their material in national journals. Reprints of these articles are purchased to be included in the Supplementary Series in Oceanography, maintained by the University. In addition to this, the University maintains the Publications in Oceanography.

#### HAWAIIAN ISLANDS

##### Marine Biological Laboratory at Honolulu ('34)

*Location:* On the shore in the Waikiki district, about 4 miles from the center of Honolulu, about an equal distance from the main campus of the University of Hawaii.

*Organization to which attached:* University of Hawaii.

*Purposes:* Instruction and research. Instruction: in marine ecology given to the students of the University; research: advanced and graduate students have the privileges of the laboratory. There is also room for a limited number of special investigators who wish to carry on independent research.

*Scope of activities:* In addition to instruction, researches in ecology including growth and development of marine organisms; quantitative studies of zooplankton; taxonomy of marine animals.

*Equipment:* 1 laboratory building, 1 floor, 35 x 80 feet, with running fresh and sea water, electricity, gas, etc.

Laboratory adjacent to Honolulu aquarium which can be utilized for purposes of research.

*Staff:* Director, Prof. C. H. Edmondson; Assistant, Mr. J. M. Ostergaard.

*Provisions for visiting investigators:* Room available for 1 or 2 throughout the year, and 3 or 4 from June to September.

*Income:* Maintenance through the budget of the University of Hawaii. No special income or contributions.

#### CHILE, ECUADOR, PERU

Very little information could be obtained on oceanographic activities in the countries on the west side of South America, except Peru. For some time records of sea-surface temperatures have been kept at the Peruvian Escuela Naval at La Punta and the Compañía Administradora del Guano has kept records of several kinds and has assisted in the prosecution of research on oceanic phenomena. It is planned to extend the oceanographic work of both the Hydrographic and Meteorologic services, but detailed information on them is not available. The outlook is good for significant contributions from those sources.

#### CHILE

##### Servicio Meteorológico

*Location:* Santiago, Quinta Normal, Casilla 717.

Detailed information not available.

##### Departamento de Navegación, República de Chile ('37)

*Location:* Valparaíso.

*Staff:* Hydrographer, Capitán de Navío Enrique Cordovez Madariaga.

Assistant Director and Inspector of Navigation, Capitán de Fragata, Alfredo Novion Valek.

Head of Section of Nautical Information, Teniente 1° en Retiro, Rodolfo García Bouquet.

Cartographer, Horacio Justiniano Marutana.

Head of Section of Instruments, Teniente 2° en Retiro Cristian, Wiegand Ognio.

Head of Section of Cartography and Engraving, Dibujante 2°, Octavio Quiñones Morales.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
AGUILA.....	600	6	100
LEUCOTON.....	550	4	50

#### ECUADOR

##### Servicio Hidrográfico de la Armada ('37)

*Location:* Guayaquil.

*Staff:* Hydrographer, Capitán de Fragata Luís E. Jarrin G.

Chief of Hydrographic Section, Teniente de Fragata Miguel Zea.

Chief of Section for Calculations, Calculador 1° Angel Valdez.

Chief of Section for Tides, Calculador 2° Hector Chiriboga.

Chief of Topographical Section, Calculador 2° César Crespo.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
COTOPAXI.....	300	6	50
CONTRAMAESTRA SUAREZ.....	27	1	8

PERU

**Servicio Hidrográfico y Faros (Hydrographic and Lighthouses Office) ('37)**

*Location:* Calle Estados Unidos No. 4, Chucuito, Callao.

*Staff:* Head of Service, Capitán de Fragata A. P. Victor S. Barrios.

Head of Section of Lights, Capitán de Corbeta Ingeniero A. P. Alfredo Rivarola.

Head of Section of Navigation, Tenete 1° A. P. Julio A. Raygada.

**Escuela Naval ('34)**

*Location:* La Punta.

*Activities:* Keeps records of sea-surface temperatures.

**Compañía Administradora del Guano ('37)**

*History or origin:* Originated as a semi-official corporation about 1909. (First "Memoria" published in 1909.)

*Location:* Lima, Peru (Casilla 2147).

*Organization to which attached:* Independent.

*Purposes:* Administration of the Guano Islands. Increase of the Guano supply; excavation, and distribution of Guano.

*Scope of activities:* Everything pertaining to above, including work in applied science, and in pure science on occasion.

*Equipment:* Extensive fleet of craft. Laboratories on the islands. A main laboratory at Lima of the "Sección Técnica," and numerous testing and demonstration projects.

*Staff:* Señor Francisco Ballen ("Gerente"). Numerous associates and assistants, including trained "agricultural engineers."

*Provision for visiting investigators:* The Compañía is hospitable to visiting investigators.

*Provision for the publication of results:* A monthly "Boletín," one number of which is the "Memoria" or annual report. Agricultural, meteorological, zoological, and oceanographic reports and abstracts.

**Servicio Meteorológico del Peru ('36)**

*Location:* Lima, apartado 1308.

*Activities:* An effort is being made to establish stations for observing surface water-temperatures and collecting water samples at numerous places along the Peruvian Coast, notably at ten of the principal ports and on all the Guano Islands.

*Staff:* Director, G. A. Wagner.

# INSTITUTIONS, WEST SIDE OF THE PACIFIC OCEAN

## AUSTRALIA TO JAPAN, INCLUSIVE

### AUSTRALIA

#### Low Island, Queensland ('37)

*History or origin:* A small marine station was established in 1928 by the Great Barrier Reef Committee of Australia as a base of operations for the British-Australian Great Barrier Reef Expedition of 1928-29. The building was destroyed by a cyclone so that now there is on the island only a hut.

*Location:* Eight and one-fourth miles east from Port Douglas and thirty-six and one-half miles N.N.E. of Cairns; lat. 16°23' south; long. 145°35' east. Area of island three and one-half acres; six feet above high-water; rough coral gravel and sandy ground; lighthouse in center of island (65 ft. high).

*Organization to which attached:* The Queensland Government and the Great Barrier Reef Committee of Australia.

*Purposes and scope of activities:* Now there is no one at Low Island. Therefore there is no program.

*Provisions for visiting investigators:* The above mentioned hut could be used for visiting scientists.

#### The Australian Hydrographic Service ('37)

*History or origin:* Until 1920 hydrographic surveys in the vicinity of Australia were undertaken by the British Admiralty using ships of the Royal Navy when responsibility for this work was taken over by the Australian Government.

In 1920 the Australian Hydrographic Branch was established as part of the Royal Australian Navy and H.M.A.S. GERANIUM was commissioned as the first surveying ship and was employed in surveying various harbors and harbor approaches; also many parts of ocean routes. The GERANIUM was paid off in 1927. H.M.A.S. MORESBY was commissioned in 1925 and until 1930 was employed surveying the waters of the Great Barrier Reef—occasionally also carrying out surveys elsewhere.

*Location:* Melbourne, Australia.

*Organization to which attached:* Naval Board, Department of Defense.

*Purposes and scope of activities:* Collates data obtained by hydrographic surveyors, prepares and publishes local charts and arranges for the promulgation, in the form of Notices to Mariners, etc., of hydrographical information received. The MORESBY in 1933 resumed the survey of the Great Barrier Reef. In (1934) she commenced a survey of the waters off the northwest coast of Australia.

#### Equipment:

SURVEYING VESSEL	DISPLACEMENT	OFFICERS	CREW
MORESBY.....	1,650	12	129

*Staff:* Director, Hydrographic Branch.

*Provision for publication of results:* All Fair Charts and other surveying data obtained by the Australian Hydrographic Surveying Service are transmitted to the British Hydrographer for the production of British Admiralty Charts. In many cases, however, temporary charts are produced in Australia for sale and use, pending the issue of Admiralty Charts, which usually are not available until some two years later.

#### Marine Meteorological Section, Commonwealth Meteorological Bureau ('34)

*History or origin:* In 1908, the Commonwealth Meteorological Bureau was formed by the Federal Government taking over the meteorological services of the various States.

Soon afterwards a few marine observers were enrolled to keep meteorological logs for this office, and later, upon the development of radio-telegraphy, W/T reports were obtained from a few liners and Australian coasting ships. These radio-telegraphic reports, however, ceased in wartime.

In 1922 the marine meteorological service was re-organized and there was established a regular service of both radio-telegraphed and log reports from selected ships. The volume of such reports has since been considerably increased, and procedure has been brought into accordance with international practice. Recently the supply of log reports was augmented by the loan of British

ships' registers of observations recorded in this part of the world.

*Location:* At the Commonwealth Meteorological Bureau, Central Office, Victoria Street, Melbourne.

*Organization to which attached:* Meteorological Bureau, Commonwealth Department of the Interior.

*Purposes:* To collect marine meteorological data relating to that part of the Southern Hemisphere between 80° East longitude, and 150° West longitude.

The Marine Section arranges for the enrollment, instruction, and, as far as funds permit, for the equipment of marine observers on Australian ships.

Log reports from ships of other countries also are arranged for from time to time, but only when such observers' reports are not required by the Meteorological service of the country in which the ships are registered.

*Scope of activities:* As far as possible:

(a) The completion of a daily isobaric chart of the area indicated under "Purposes" and combining reports of ships and of land stations in the area;

(b) Calculating of monthly normals (for each 5° square) of the meteorological elements included in the ships' reports; and

(c) Collection and investigation of reports of tropical cyclones, and of miscellaneous phenomena reported by ships.

*Equipment:* A few of the ships enrolled as marine observers of the Central Meteorological Bureau are equipped with official mercurial barometers, and with sea water thermometers. The number of ships thus equipped will gradually be increased as funds become available.

In the case of most of this Bureau's observers, however, the readings of the ships' barometers are used, barometers being checked and index error corrections supplied as required.

For particulars regarding the equipment of ships, the data of which are borrowed from the British Meteorological Office, it is desired to refer to the relevant section of the statement supplied by the British Meteorological Office.

*Staff:* Headquarters: 1 meteorologist; 1 meteorological assistant.

*Agencies:* 5 agents, the Divisional Meteorologists of Sydney, Brisbane, Adelaide, Perth, and Hobart.

*Provision for visiting investigators:* As occasion arises.

*Income:* By parliamentary vote as part of the appropriation for the Department.

*Provision for publication of results:* Results may eventually be published by the Government printer if funds can be obtained for the purpose.

### **Fisheries Department of the Commonwealth of Australia ('37)**

*History or origin:* In the year 1935 the Commonwealth Government definitely established a Fisheries Department under the care of the Council for Scientific and Industrial Research, a governmental body responsible for industrial branches of research.

*Location:* Sydney, Australia.

*Organization to which attached:* Council for Scientific and Industrial Research of the Commonwealth Government of Australia.

*Purpose and scope of activities:* Fisheries research. It is planned to make a special investigation of the possibilities of pelagic fisheries.

*Equipment:* Besides facilities for laboratory work a research vessel about 83 feet long of the purse seiner type, with a diesel engine, is under construction and will soon be commissioned.

*Staff:* Scientific Adviser, W. J. Dakin, Professor of Zoology, University of Sydney; Officer in charge, Dr. H. Thompson.

### **Marine Laboratory of the University of Sydney ('37)**

*History or origin:* The Laboratory was set up at the instigation of Professor W. J. Dakin, Professor of Zoology, the University of Sydney. The money available for the initial effort was part of a fund collected many years ago for the foundation of a Sydney Biological Station.

*Location:* At the entrance to Sydney Harbour, coast of N. S. W., in closest approximation to the open ocean.

*Organization to which attached:* University of Sydney, Department of Zoology.

*Purposes:* Chiefly research, marine biology, and oceanography. Also instruction for senior classes.

*Scope of activities:* Investigations in plankton; hydrographic conditions to a distance of about five miles off-shore east of Sydney; physiological studies of certain marine organisms; physical, chemical oceanography.

*Equipment:* 1 small temporary laboratory, single floor 36 ft. by 12 ft. but closely associated (only half hour journey) with University laboratories and libraries. Separate aquarium room with few

small tanks and 1,000 gallon tank with pump. Auxiliary yacht of 13 tons, with oceanographic apparatus.

*Staff:* Director, Professor W. J. Dakin, Department of Zoology, University of Sydney; Doctor E. A. Briggs; A. N. Colefax, B.Sc.; 4 clerical and technical assistants.

*Provisions for visiting investigators:* One or two research investigators would be welcomed, but would mainly work in University buildings using station as essential accessory.

*Income:* About £180 per annum.

Source: University of Sydney, Commonwealth Council for Scientific and Industrial Research, Australian Research Council, Private.

*Provision for publication of results:* Papers published in scientific periodicals (chiefly Proceedings Linnæan Soc. of New South Wales).

## CHINA

### Summer Survey of the Marine Biological Association of China ('36)

*Location:* The Marine Biological Station, University of Amoy, Amoy, Fukien.

*Organization to which attached:* Marine Biological Association of China.

*Purposes:* Research in the summer season every year.

*Scope of activities:* A continuation of the systematic survey of certain specified groups of the fauna and flora of Amoy, including studies in the morphology, ecology, life history, and food value of these specified groups only.

*Equipment:* The providing for laboratory and library facilities, housing accommodations are all contributed by the University of Amoy.

*Staff:* Director, Dr. T. Y. Chen; 12 senior investigators and 6 junior investigators invited by the Executive Committee of the Association from among those biologists of professorial rank in the different institutions in China who are prepared and willing to work on one of the specified topics.

The University of Amoy also contributes the service of its staff.

*Provisions for visiting investigators:* Specialists in other groups of animals and plants are to be cordially invited to coöperate with the Association in helping to work up the material of the respective groups collected during the session.

*Income:* The China Foundation and the Rockefeller Foundation give grants of \$5,000 each for carrying on the summer survey.

### Hydrographic Department of the Chinese Navy ('37)

*History or origin:* This department has been established since 1922, under the authority of Ministry of Navy.

*Location:* 140 Municipality Road, Shanghai.

*Organization to which attached:* Ministry of Navy.

*Purposes:* Hydrographic survey.

*Scope of activities:* Coast and river surveys.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
KANLU.....	1,398	12	116
CHIAO JIH.....	500	9	85
CHINGTIEN.....	279	4	55
KING HSIN.....	140	4	35
KUNG SHENG.....	280	10	35
CHENG SHENG.....	276	10	35

*Staff:* Director, Captain T. P. Liu.

Asst. Director and Chief of Technical Staff, Mr. S. V. Mills.

Chief of Administrative Section, Commander V. H. Koo.

Chief of Section of Surveying, Captain K. Y. Chen.

Chief of Section of Cartography, Captain T. Chen.

Chief of Section of Calculations, Commander S. Y. Lee.

Chief of Section of Tides, Commander K. S. Yeh.

*Provisions for visiting investigators:* None.

### Tinghai Marine Station ('36)

*History or origin:* 1936.

*Location:* Sen-Kia-Men, Chusan Islands, Chekiang (30°N. 120°20'E.)

*Organization to which attached:* National Research Institute of Biology, Academia Sinica.

*Purposes:* Biological and oceanographic research.

*Scope of activities:* As a center of oceanographic and marine biological researches of the Chinese coast.

*Equipment:* In preparation.

*Staff:* Dr. Chin-Chih Jao and others.

### Tsingtao Aquarium ('36)

*Location:* Beach Park, Tsingtao.

*Organization to which attached:* Chinese Institute of Oceanography.

*Purposes:* Research and exhibition.

*Scope of activities:* To advance the aquatic knowledge in popular education and to provide the facilities for special research in marine biology.

*Equipment:* 1 building, 3 stories with basement including 2 specimen show rooms; 18 glass-

fronted exhibition tanks; 2 ground pools; 1 laboratory for chemical and biological researches; 1 distributing tower; 1 sea-water reservoir; 1 pump house.

*Staff:* Director, Mr. P. Z. Tsiang; 1 in charge of general affairs; 2 research and technical assistants; 2 clerical assistants; 1 collector.

*Provisions for visiting investigators:* Maximum 5, in addition to the aquarium's staff, can be accommodated.

*Income:* Partly subsidized by the local government and partly by the subscriptions from various scientific institutes.

The aquarium is in coöperation with the staff of the oceanographic department of Tsingtao Observatory and receives help in its researches from the professors of the Tsingtao University and visitors from other institutions.

#### **Department of Oceanography, Tsingtao Observatory ('36)**

*Location:* Observatory Hill, Tsingtao.

*Organization to which attached:* Tsingtao Observatory of which it is a department.

*Purposes:* Mainly for research.

*Scope of activities:* Research in dynamical oceanography, marine meteorology, chemistry of sea water, marine biology, and sea bottom deposits.

*Equipment:* 1 service building (part of the Observatory); 1 hydrographic and meteorological station at the Great Harbor, equipped with a self-registering tidal gauge and a complete set of meteorological instruments; 1 library, more than 4,000 volumes of scientific books; 1 research boat, borrowed from the Bureau of Safety, Tsingtao, equipped with a complete set of instruments for hydrographic investigations; 1 chemical laboratory in preparation.

*Staff:* In charge, Mr. P. Z. Tsiang; 2 investigators; 2 clerical and technical assistants; 2 collectors and observers.

*Provisions for visiting investigators:* None.

*Income:* Regular for the year 1931-32, \$10,000.

#### **FRENCH INDO-CHINA**

##### **Institut Océanographique de l'Indochine ('36)**

*History or origin:* Established in 1922 by the General Government of Indo-China under the name of Service Océanographique des Pêches de l'Indochine; converted into a publicly supported institution with a civil personnel in 1930 under the name of Institut Océanographique de l'Indochine.

*Location:* On the seashore, 6 kilometers south of the city of Nhatrang (Annam), 450 kilometers north of Saigon, the capitol of Cochinchina.

*Organization to which attached:* Placed under the scientific control of a commission composed of 13 members of the Academy of Sciences of Paris.

*Purposes:* Scientific and technical researches and the establishment of a museum.

*Scope of activities:* Physical and biological oceanography, limnology, potamology; inventory of the aquatic fauna, biology of fishes, invertebrates, and plankton; and the study of the sea bottom. Industrial utilization of marine products.

*Equipment:* A principal building of two stories, 35 x 15 meters, containing a ground floor and a gallery for collections. On the first floor a veranda for aquaria and three laboratories. On the second floor, three laboratories.

1 annex, a building with two stories 15 x 7.80 meters, containing gas producing apparatus and drafting room.

Aquarium.

An experimental factory for the semi-industrial study of products prepared in the laboratory (fish meal and salt fish).

Library.

A hangar for fishing nets.

A jetty 90 milometers long.

Self-registering tidal gauge.

Tunnel of 130 meters long, excavated in rhyolite, intended to house a seismograph.

5 dwelling houses for the personnel, 1 building containing garages for automobiles and lodging for the chauffeur.

1 research vessel, the DE LANESSAN of 750 tons displacement, length 45 meters, beam 63 meters, draught 4.45 meters; equipped for sounding to a depth of 5,000 meters; provided with a scientific laboratory, aquaria supplied with running fresh water and sea water, and a technical laboratory; cruising radius 1,000 miles.

*Staff:* Director, Dr. P. Chevey; Assistant biologist, R. Serène, Lic. Sci.; Economist, J. Durand; Captain of the vessel, M. Dauguet; 1 mechanic; preparators, draughtsmen, photographers, et cetera (Annamites).

*Provisions for visiting investigators:* Four or five investigators can eventually be received at the laboratory and one or two on board the DE LANESSAN.

*Income:* In 1932, \$175,000, in 1933 \$87,500 (the unit of the funds is the piastre). This is an

appropriation from the general budget of Indo-China. This amount will be still further reduced in 1934. The Institution, occupying a civilian status, has the right to receive gifts from different sources, but up to the present it has been obliged to content itself with subsidies from the General Government.

*Provision for the publication of results:* Two series "Notes," of which 122 have been issued; and "Memoirs," of which three have been issued.

#### HONG KONG

##### Royal Observatory, Hong Kong ('34)

*Location:* Kowloon.

*Organization to which attached:* Government of Hong Kong.

*Purposes:* Primarily meteorological but this includes studies of marine meteorology.

*Scope of activities:* Meteorology, terrestrial magnetism, and seismology.

*Equipment:* Offices, instruments, arrangements for reports of observations.

*Staff:* Director, Mr. C. W. Jeffries; Assistant Director, Mr. B. D. Evans; Professional Assistant, Mr. G. S. P. Heywood.

*Provision for the publication of results:* The Observatory has published an atlas entitled, "Maps Showing the Mean Atmospheric Pressure and Wind Direction and Force over the China Sea for Each Month of the Year," 1925; "Meteorological Records," 1884-1928, Appendix to Hong Kong Observations 1928, 1929; "Climate of Hong Kong," by T. F. Claxton, Appendix to Hong Kong Observations, 1931; "Weather Observations from Ships," Appendix to Hong Kong Observations, 1931. According to an arrangement adopted by the Directors of the Far Eastern Weather Services made at a conference held at Hong Kong in 1930, the records of observations received from ships by wireless telegraphy are published in rotation by the different Far Eastern Weather Services represented at the conference.

#### JAPAN

##### Akkeshi Marine Biological Station ('37)

*Location:* On the sea front of the gulf Akkeshi, about 70 km. east of Kushiro and 150 km. west of Nemuro.

*Organization to which attached:* The Faculty of Science, Hokkaido Imperial University.

*Purposes:* Research, instruction for students.

*Scope of activities:* Research in biology and oceanography.

*Equipment:* 1 concrete building, 788 sq. m., 3 floors including 1 student laboratory; 1 laboratory for investigators; 5 staff laboratories; 1 aquarium room of 10 tanks; 1 library; 1 public room; 1 office; 1 motor room; 1 motor boat MISAGO, 8 meters, 5 tons; 2 wooden residences.

*Staff:* Director; 4 associates (1 temporary); 4 research assistants (1 temporary); 2 part-time collectors.

*Provisions for visiting investigators:* Six to ten persons can be accommodated.

*Income:* Yen 6,000 for 1932, from the Faculty of Science.

##### Amakusa Marine Biological Laboratory (Amakusa Rinkai Jikken-sho) ('37)

*History or origin:* Established in 1928. For a fuller description, see article mentioned in the foot-note.<sup>1</sup>

*Location:* Tomioka, Amakusa, Kumamoto ken, Japan, about 31 km. southeast of Nagasaki.

*Organization to which attached:* Kyushu Imperial University.

*Purposes:* Researches by investigators associated with the laboratories and institutes of zoology, botany, physiology, biochemistry, anatomy, pathology, geology, meteorology, et cetera, of the University, and of other universities and colleges.

*Scope of activities:* Chiefly the survey of the marine fauna and flora around Tomioka and its vicinity. Casual visitors may take up any field of research in marine biology, oceanography, and other related branches of science.

*Equipment:* 1 wooden laboratory building, 2 stories, floor area of 100 sq. m.; 1 janitor's house and kitchen, 1 story, 66 sq. m.; 1 dormitory, 1 story, wooden, 100 sq. m.; land, area about 62,000 sq. m.

*Staff:* Director (professor in Kyushu Imperial University); 2 members of council (professors in Kyushu Imperial University); 1 administrator; 1 assistant; 1 artist; 1 janitor; part-time collectors and helpers.

*Provisions for visiting investigators:* For about 5 or 6 persons only.

*Income:* Very irregular in amount, paid whenever required by the University.

<sup>1</sup> Ohshima, Hiroshima, The Amakusa Biological Laboratory: Records of Oceanog. Works in Japan, vol. 1, no. 2, pp. 78-89, pls. 22, 23, 2 charts, 1928.

### Marine Biological Station of Asamushi ('37)

*Origin:* The following is quoted from the article cited below.<sup>2</sup>

The Asamushi Marine Biological Station was founded in July, 1924, as an extension of the Institute of Biology, Tôhoku Imperial University, Sendai, Japan. During the years, 1921-1922 one of the authors (S. Hatai) and his colleagues at the Biological Institute made a thorough investigation of the entire coast of Northeastern Japan to select the most suitable site for a marine biological station. Although the coast of Miyagi Prefecture was naturally most thoroughly searched the present location in Aomori Prefecture was selected, after careful consideration, as the most suitable for our purpose. By act of the 46th. Diet, in session in 1923, the Imperial Japanese Government granted 150,000 yen for establishing the Station, and 50,000 yen was given by the Aomori Prefectural Government. Thus the erection of the buildings could be commenced in May, 1923, and was completed one year later, entailing a total expense of 200,000 yen. The Station was formally opened on July 5th, 1924.

During the four years since its establishment, various improvements have been made, and the station is now fast becoming one of the centers for the promotion of Biological Science in Japan.

*Location:* Asamushi, Aomori-ken, on the sea front, about 1.6 km. northeast of the village of Asamuchi. about 16 km. northeast of city of Aomori, and about 17 hours by train from Tokyo.

*Organization to which attached:* The Faculty of Science, Tôhoku Imperial University.

*Purposes:* Major purpose, research; instruction in zoology, physiology, and planktology.

*Scope of activities:* Research in physiology, zoology, physiological chemistry, planktology, and oceanography.

*Equipment:* 1 laboratory building, 2 floors, 386 sq. m., of 14 rooms: 8 research rooms for faculty, student laboratory, physiological laboratory, library, dark room, reception room, janitor's room; all furnished with gas, electricity, running sea and fresh water.

1 undersea laboratory, designed for study of experimental evolution, physiology, and ecology, re-enforced concrete, 15 sq. m., one-half submerged in the sea at the shore line.

<sup>2</sup> Hatai, Sinkishi, and Kokubo, Seiji, The marine biological station of Asamushi: Its history, equipment, and activities: Records of Oceanog. Works in Japan, vol. 1, no. 1, pp. 26-38, pls. 6-12, 1928.

1 aquarium house, re-enforced concrete, 238 sq. m., business room, aquarium, museum. 24 tanks of various sizes, in which both fresh and sea water fishes are on display to the public.

1 boat house, 70 sq. m., for conservation of motor boats during the winter.

2 motor boats; one, 8 meters, 20 h.p. gasoline engine, furnished with fish tank for transporting live fishes; one 7 meters, 8 h.p. engine.

2 small fishing boats, portable motors.

1 dormitory, 2 story frame building, capable of accommodating 50 persons, area 636 sq. m.

4 official residences, 116 sq. m. each, of 3 to 5 rooms in addition to veranda, kitchen, bath, furniture, running water, electricity.

*Staff:* Director, Doctor Hatai; Curator, Dr. S. Kokubo; 3 assistants; 1 technical assistant.

*Provisions for visiting investigators:* Between 20 and 30 can be accommodated besides the staff.

*Income:* The regular income is Yen 21,000 per year including salaries, besides a special income of Yen 6,000 derived from the aquarium.

*Provision for the publication of results:* Scientific reports of Tôhoku Imperial University.

### Imperial Marine Observatory, Kobe ('37)

*History or origin:* Established in 1919.

*Location:* Nakayamate-dori 7 tyome, Kobe.

*Organization to which attached:* Department of Education.

*Purposes:* Marine meteorology and oceanographic investigations.

*Equipment:* Besides the laboratory and office building in Kobe, the Observatory operates the M. S. SYUNPU-MARU, a steel yacht of 125 tonnage, specially intended for oceanographical surveys, built in 1927. Principal dimensions: length over all 90 feet, breadth 18 feet, depth 9.6 feet, mean draft 7 feet, displacement of 125 tons; equipped with a six cylinder Diesel engine of 150 horsepower; speed 9 knots in calm weather; carries 13 tons of crude oil in three oil tanks; cruising radius of about 2,500 miles at a mean speed of 8 knots.

Personnel, a captain and a crew of 16 in all. Oceanographical observations are conducted by the experts of the Observatory assisted by the crew. Four sounding instruments of the Lucas and Wurzel types are fitted on board. Temperature, density, salinity, acidity, etc., at various depths are observed in usual ways, and the

direction and speed of ocean currents are observed with current meters of the Ekman pattern.

*Staff:* Director, Dr. T. Okada; Meteorologist, Y. Horiguti; Meteorologist, K. Tsukuda; Oceanographer, K. Hidaka; Oceanographer, K. Koenuma; Instruments, G. Okada; Marine chemist, Y. Matudaira; Marine Biologist, T. Yanagisawa.

*Income:* Yen 160,000 (annual).

*Provision for publication of results:* Annual Report; Memoirs of the Imperial Marine Observatory; Daily Weather Charts of the North Pacific; Journal of Oceanography; Tidal Observations.

#### **Kominato Marine Biological Laboratory ('37)**

*Location:* On the sea shore of Kominato Bay, about 1.6 km. south of Awa-Kominato Railway Station, Chiba Prefecture, and about 121 km. from Tokyo via the Boso Railway Line.

*Organization to which attached:* Imperial Fisheries Institute, Tokyo.

*Purposes:* Research and instruction in marine biology.

*Scope of activities:* Researches in biology, under which planktology, biology of fishes are included; chemistry and physics of sea water; dynamical oceanography.

*Equipment:* Total site 5,000 sq. m.; 1 re-enforced concrete laboratory building, including aquarium, 2 floors, 165 sq. m. First floor aquarium with 11 tanks; second floor laboratory; 1 wooden dormitory, 2 floors, 121 sq. m.; 1 wooden bath house, building area 9.9 sq. m.; 2 wooden cottage residences; 2 engine houses; 1 fish pond, about 40 x 20 x 8 ft.; sea water tank, about 24,000 gallons capacity, re-enforced concrete structure; boat house; 1 re-enforced concrete pier, about 20 ft. x 5 ft.; 1 research boat; Library, about 200 volumes, 100 reprints.

*Staff:* 6 in charge of different lines of investigation. Director; 3 associates; 1 resident naturalist; 1 collector.

The investigations also receive help in research from members of the Fish Culture Department of the Imperial Fisheries Institute and visitors from other institutions.

*Provisions for visiting investigators:* About 20, in addition to staff.

*Income:* One year's expenses, about Yen 500 regularly. In addition there is a special contribution from Kominato Town.

#### **Institute of Physical Oceanography ('34)**

*History or origin:* Established in 1921.

*Location:* Kyoto, Japan.

*Organization to which attached:* Ôsaki Tidal Station.

*Purposes:* Instruction and research.

*Scope of activities:* Physical oceanography in general.

*Equipment:* Ordinary equipment for research in physics.

*Staff:* Takaharu Nomitsu; Yoshikazu Toyohara; Tohichiso Takegami.

*Income:* Source: From the Government.

Amount: Yen 3,000 annually for research.

*Provision for publication of results:* In "Memoirs of the College of Science," Kyoto Imperial University, Series A.

#### **Misaki Marine Biological Station (Misaki Rinkai Jikkenjo) ('37)**

*History or origin:* Founded in 1886.

*Location:* About 60 km. south of Tokyo, 3 km. north of the village of Misaki, Kanagawa Prefecture; one hour by train and 50 minutes by bus.

*Organization to which attached:* Imperial University of Tokyo.

*Purposes:* Research by investigators associated with the laboratories and institutes of zoology, botany, fisheries, and medical sciences of the University, and visiting investigators; laboratory for college students of zoology; summer courses.

*Scope of activities:* Marine biology, oceanography, and allied sciences. Aquarium and museum are open to the public; summer courses in marine zoology for public and high school teachers; oceanographic observations; seismological observations; research facilities extended to visiting investigators.

*Equipment:* 1 laboratory building, reinforced concrete, 59 x 13.5 m., with floor space 1,000 sq. m. including chemical, physiological, and oceanographical rooms besides general laboratory; 1 office and laboratory, wood, 12 x 9 m.; 1 aquarium-museum building, reinforced concrete, 2 stories, 29.7 x 7.2 m., with floor space 363 sq. m.; 1 seismograph room; 3 dormitory buildings, including residence for overseas investigators; 1 wooden cottage for staff; 1 motor boat; 3 row boats.

*Staff:* Director, Prof. Naohide Yatsu; 1 assistant professor; 1 research associate; 1 assistant; 1 general manager; 1 technician; 4 collectors; 2 janitors.

*Provisions for visiting investigators:* Five or six can be accommodated.

*Income:* Annual budget about Yen 12,000 including salaries (from Science Faculty and Agricultural Faculty), and about Yen 4,500 from admittance tickets of the aquarium and museum, and from table fees.

*Provision for publication of results:* Journal of Faculty of Science, Section IV, Tokyo Imperial University.

#### **Miyako Meteorological Observatory ('37)**

*History or origin:* New observatory completed at the end of 1936. The principal object of this observatory is to observe the temperature of sea water off the east coast of N. Japan every day when the weather permits.

*Location:* Miyako. 39°38' N., 141°59' E.

*Organization to which attached:* The Central Meteorological Observatory, Tokyo.

*Purposes and scope of activities:* Meteorological and oceanographic observations.

*Equipment:* Besides a small laboratory for marine chemical work, the observatory operates a motor yacht KUROSHIWO-MARU, 30 tons, and 9 knots in speed.

*Staff:* Director, Y. Tudi.

*Provisions for visiting investigators:* None.

*Income:* Yen 10,000 (annual).

*Publication:* The results of observations made at this observatory are published in the publications of the Central Observatory, Tokyo.

#### **The Institute of Algological Research (Kaiso Kenkyusho) ('37)**

*History or origin:* Established in May, 1933. A new laboratory was completed in April, 1937.

*Location:* Hunami-cho, Muroran, Hokkaido, Japan.

*Organization to which attached:* The Hokkaido Imperial University.

*Purposes:* Research works on the marine algae.

*Scope of activities:* Systematic, cultural, physiological, and ecological studies on marine algae.

*Equipments:* In the laboratory, one large and two small rooms for research, three rooms for culture studies; two small boats; a lodging for visitors.

*Staff:* Scientific: Y. Yamada, Professor of Botany, Hokkaido, Imperial University; T. Kanda, Assistant. Technical and clerical, 1. Maintenance and operation, 2.

*Provisions for visiting investigators:* No special provision.

*Income:* Sources: The Hokkaido Imperial University. Amount: Not fixed.

#### **Palao Tropical Biological Station ('37)**

*History or origin:* Established in compliance with a recommendation of the Committee of the Biological Section of the Japan Society for the Promotion of Scientific Research, organized in 1932. After the approval of this recommendation by the trustees of the Society a subcommittee was formed and it was decided to establish a biological station in the tropical islands under Japanese mandate. Prof. S. Hatai who was chosen to carry out this proposal, after visiting numerous islands, selected as the site of the station the Island of Korrer, which is near the main island of Palao. The buildings were completed in 1935. For a fuller description see article cited below.<sup>3</sup>

*Location:* On Korrer Island, situated close to the main island of Palao, the South Sea Islands of Japanese mandated territory.

*Organization to which attached:* The Japan Society for the Promotion of Scientific Research, Tokyo.

*Purposes:* Major purpose, research in biology of coral reefs.

*Scope of activities:* Researches in ecology of coral polyps and of reef formation, in physiology of growth, development, and reproduction in each coral species, in physics and chemistry of coral skeleton; and general biological and oceanographical survey necessary for investigation of the above mentioned fields.

*Equipment:* 1 laboratory building, one storied frame building, about 7 x 11 meters, of a single large laboratory and a small dark room for photographic work.

1 store room, about 5.5 x 3.6 meters; under the same roof is the motor room.

1 small exhibition house of coral specimens.

2 collecting boats: one, equipped with a kerosene oil engine of 3 h.p., and another, a small row boat with sailing gear.

For long distance trips the government Fisheries Experimental Station at Palao has generously placed its large craft at disposal of the station.

1 salt water tank, capacity 3 tons.

2 fresh water tanks, capacity 3 tons each.

2 residences, about 6 x 8 meters each.

<sup>3</sup> Hatai, Sinkishi, The Palao Tropical Biological Station: Palao Tropical Biological Studies, no. 1, pp. 1-15, 6 figs., 1937.

*Staff:* Director, Prof. S. Hatai; 3 commissioners (2 in Palao, 1 in Sendai); 2 janitors.

*Provisions for visiting investigators:* Four can be accommodated, including the staff and research members sent by the Society.

*Income:* Annual budget for 1937: 12,200 yen.

*Provision for the publication of results:* The Palao Tropical Biological Studies, issued by the Japan Society for the Promotion of Scientific Research, Tokyo.

#### **Seto Marine Biological Laboratory (Seto Rinkai Kenkyusho) ('37)**

*History:* An account of the establishment of the Seto station is given in the article cited below<sup>4</sup> and from it the following is quoted:

The Department of Biology (now the Departments of Zoology and Botany) of the Kyoto Imperial University was established in 1917, and four years later, in 1921, the Government granted 150,000 yen toward the erection of a marine biological laboratory to be attached to the department. This sum was spent largely for the building and equipment of the Seto Marine Biological Laboratory. It was supplemented by a contribution of 50,000 yen from Wakayama Prefecture, while a lot of nine acres and a half was donated by the village of Seto-Kanayama. The whole building was completed in the spring of 1922, and the activities began in the summer of the same year. One thing to be deeply regretted in connection with the establishment of the Laboratory, was the death of its founder, Prof. Iwaji Ikeda, which happened just before the completion of the building.

*Location:* Seto-Kanayama, Wakayama ken, on the west coast of Kii Peninsula, about 128 km. south of Osaka: 4 hours by train, 1 hour by bus, and 20 minutes on boat; or 8 hours by steamer.

*Organization to which attached:* Faculty of Science, Kyoto Imperial University.

*Purposes:* Research work on marine biology; instruction to students of Kyoto Imperial University.

*Scope of activities:* Researches in marine biology, including systematics, morphology, embryology, ecology, physiology, planktonology, et cetera; lectures, laboratory courses in marine biology for

University students; special courses in marine biology for teachers of middle and primary schools, usually attended by about 30 persons; exhibit of marine life for public.

*Equipment:* Buildings are all wooden and one storied; 1 students' laboratory, 220 sq. m.; 1 research laboratory, 264 sq. m.; 1 library-museum, 13 sq. m.; 1 aquarium building, 186 sq. m.; 1 dormitory, 395 sq. m.; 1 residence for resident members, 61 sq. m.; 1 collecting boat NYUSIN MARU, 14.4 x 3.9 m., 19 tons, semidiesel engine; 1 small boat; 2 row boats.

*Staff:* Acting Director, Prof. Y. Okada; Assistant Prof. K. Akatsuka; 1 assistant; 1 technical assistant; janitor and cook.

*Provisions for visiting investigators:* 10 at most; usually about 5.

*Income:* Sources: University of Kyoto.

Amount: Fluctuates from year to year, about Yen 3,000, excluding the salaries of the staff from Kyoto Imperial University.

*Provision for publication of results:* Mostly in Mem. Coll. of Science, University of Kyoto, also in other journals.

#### **Mitsui Institute of Marine Biology ('37)**

*History or origin:* Established and opened in 1933 by Mr. Takanaga Mitsui.

*Location:* Susaki near Simoda, Kamo-gun, Siduoka-prefecture.

*Organization to which attached:* Independent institution.

*Purposes:* Research in marine biology.

*Scope of activities:* Researches in marine biology in general, planktology, algology, physiology, and oceanography; biological survey of the neighboring waters, especially of deep-sea fauna of Suruga Bay.

Fellowships are awarded annually by the committee of the Institute to the research workers who desire to investigate marine material in the Institute.

*Equipment:* 1 laboratory building, reinforced concrete, 2 floors, 297 tubo (1 tubo = 6 x 6 ft.), of 25 rooms: 9 research rooms, 2 libraries, 3 store rooms, 2 constant temperature rooms, 2 seismological observatories, office public hall, museum, engine room, aquarium room, boat house, janitor's room; all furnished with running sea and fresh water; 1 small motor boat and a few row boats for collection and oceanographical observation.

*Staff:* Scientific: Director (changeable by 3 years'

<sup>4</sup> Komai, Taku, and Ikari, Jirô, The Seto Marine Biological Laboratory, its equipment, and activities, with remarks on the fauna and flora of the environs: Records of Oceanog. Works in Japan, vol. 1, no. 3, pp. 113-129, pls. 27-35, 1929.

term) Prof. Ikusaku Amemiya, Tokuo Imperial University (1936- ). Permanent staff: Otohiko Tanaka (oceanography and planktonology); Sokiti Segawa (algology). Naturalist: Kojiro Kato (zoology).

Technical and clerical: Clerk, Daisaku Sakata. Maintenance and operation: 2 collectors and 2 attendants.

*Provisions for visiting investigators:* At least 3 can be accommodated.

*Income:* Sources: Provided from a grant by Mr. Takanaga Mitsui.

Amount: About 20,000 yen annually.

#### Shimoda Marine Biological Station ('37)

*History or origin:* The cornerstone was laid on June 6, 1931, and completed on August 11, 1933.

*Location:* Shimoda-machi, Shizuoka-ken, Japan.

*Organization to which attached:* Tokyo University of Literature and Science.

*Purposes:* Research; instruction in zoology, botany, oceanography, geography, et cetera, and science education on the marine subjects.

*Scope of activities:* Investigations on systematics, physiology, biochemistry, ecology, experimental studies of animals and plants, meteorology, oceanography, geography, geology, terrestrial magnetism, earth current, atmospheric electricity, and others.

*Equipment:* Sea-water and fresh-water are supplied for every laboratory. Two gasoline motor-boats (16 and 5 h.p.) and four collecting boats. An aquarium is attached.

*Staff:* Scientific: T. Fukui (Director); E. Sawano (Administrator); J. Shimoizumi, T. Sakai, K. Toyomasu; S. Endo, K. Nishizawa, N. Obara.

Technical and clerical: 5 persons.

Maintenance and operation: 4 persons.

*Provisions for visiting investigators:* Ten laboratory rooms and a dormitory with ten rooms are provided for the visiting investigators.

*Income:* Sources: Tokyo University of Literature and Science.

Amount: About 3,500 yen.

#### Imperial Fisheries Experimental Station (The Suisan Sikendyô) ('37)

*History or origin:* Established in 1929.

*Location:* Tukisima, Kyobasi Ku, Tokyo.

*Organization to which attached:* Ministry of Agriculture and Forestry.

*Purposes:* Investigations, researches and experiments on fisheries and their utilization.

*Scope of activities:* Physical and biological oceanography, catching fish, fish culture, preservation of fish, utilization of fish as well as other marine products and development of fishing boats, et cetera.

*Equipment:* Laboratories and experimental stations: Head office of main station, Tokyo: 3 laboratory buildings; 1 experimental water tank for fishing boat; 2 factories for experiments; 1 freezing room for experiment.

Branch stations: (1) Kisaki station, Nagano Prefecture, for raising trout. (2) Toyohasi station, Aiti Prefecture, for raising freshwater fish. (3) Ôtyo station, Hiroshima Prefecture, for raising saltwater fish. (4) Kasaoka station, Okayama Prefecture, for raising saltwater fish.

*Staff:* Director, Dr. N. Kasuga.

Fishing, S. Kameda.

Fish technology, Kintaro Kimura, S. Yamamoto, D.Sc., and Dr. H. Hirano.

Pisci-culture, S. Nakano and S. Fujimori.

Physics, Dr. H. Hosino.

Chemistry, M. Migita, D.Sc.

Biological oceanography, H. Marukawa, Dr. Kimosuke Kimura, and Dr. H. Aikawa.

Physical oceanography, Dr. M. Uda.

In charge of fishing boat, Dr. N. Sato.

In charge of machinery, Dr. I. Gensyo.

Biology, T. Kamiya.

Branch stations: Y. Matsui, D.Sc. (Toyohasi); H. Seki (Ôtyo); M. Kawajiri (Kisaki); N. Ôshima (Kasaoka).

Captain of M. S. Sôyô MARU, K. Imamura.

*Expenditure:* Annual expense about 250,000 yen.

*Provision for publication of results:* Journal of the Imperial Fisheries Experimental Station; Fisheries Investigation (Supplementary report); Semi-annual Report of Oceanographical Investigation; Monthly Oceanographical Chart (in sheet).

#### Imperial Fisheries Institute (The Suisan Kôsyûzyo) ('37)

*History or origin:* The Imperial Fisheries Institute is the successor of the educational enterprises undertaken by the Dai-Nippon Suisan-Kwai (the Fisheries Society of Japan). Its predecessor, the Fisheries Training School, was established in 1889 by the above-mentioned society at Kobikityô, Kyôbasi, Tôkyô. In July of the same year it removed to Hakozakityô, Nihonbasi, Tôkyô, and then afterwards to Mita-Sikokutyô,

Siba, Tôkyô. The Imperial Japanese Government has donated 6,500 yen a year since 1893 to train young men for organizing and managing the fishery industries of Japan, but at the time of its transfer from the society to the Government, in 1897, the investigating and the experimental works pertaining to the fishery industries were added to its original scope, and the organization of the present Institute was founded on the 22nd of March. In 1902 new buildings were erected at Ettyûzima, Hukagawa, near the mouth of Sumida River, and the Institute removed there in September. The Institute was formerly composed of the three departments, i.e., educational, experimental, and marine investigation, but was changed into an educational organ pure and simple at the time of reorganization in 1929.

*Location:* 8 Ettyûzima, Hukagawa, Tôkyô.

*Organization to which attached:* The Institute is under the supervision of Minister of Agriculture and Forestry.

*Purposes:* The educational object of the Institute is to give lessons in science and art of the fisheries and to study the profound theories on them, along with formation of character.

*Scope of activities:* Fishing, technology of fisheries, pisci-culture, physics and chemistry, mechanics, oceanography, zoology and botany, and bacteriology, economics and laws.

*Equipment:* 2 main buildings, including 51 classrooms, 42 laboratories, a large auditorium, and 40 other rooms.

Laboratory for iodine chemistry.

Laboratory for motor machinery.

Several service buildings.

UNYÔ-MARU, 444 tons, a former training boat.

1. The steam-ship HAKUYO-MARU, 1,327.78 tons, and a wooden boat SEITYO MARU, 55 tons, are used for the purpose of training fishing students.
2. Temporary Training Station at Tateyama Bay, Tiba Prefecture, is used for training and experimental purposes of fishing students.
3. Marine Laboratory, with an aquarium, at Kominato Bay, Tiba Prefecture, is a biological laboratory used by the pisci-culture students.
4. The Oyster Experimental Station at Kanazawa, Kanagawa Prefecture, is chiefly used for the biological study of oysters and other marine life.
5. The Training Station at Yosida, Siduoka Pre-

fecture, is used for the research on raising warm-water fish.

6. The Training Station at Ôidumi, Yamanashi Prefecture, is used for the research on raising cold-water fish.

7. Training Station at Numazu, Siduoka Prefecture, is a research and training station for students of technology.

*Staff:* Director, Yasukichi Sugiura.

*Fishing Laboratory:*

Professors: T. Nagamune, K. Tanaka, J. Ihara.

Assistant professors: T. Sasayama, Dr. J.

Takagi, S. Takayama, Dr. H. Kusama.

*Technological Laboratory:*

Professors: Y. Miyama, Dr. Y. Shimizu, T. Kawaguchi.

Assistant professors: S. Iwamoto, K. Kotani, K. Saruya.

*Piscicultural Laboratory:*

Professors: Dr. N. Nakai, Dr. K. Oda.

Assistant Professor: Dr. T. Tomiyama.

*Physical Laboratory:*

Professors: M. Tauchi, D.Sc., Dr. M. Okada.

Assistant Professor: K. Miyoshi.

Instructors: Dr. S. Kamiya, Dr. Y. Takenouchi, Dr. H. Okuno.

*Chemical Laboratory:*

Professors: M. Yamakawa, D.Agr., T. Oya, D.Agr.; Y. Matsuike, D.Sc., Dr. I. Okada.

Assistant Professor: Dr. T. Tamura.

*Mechanical Laboratory:*

Professor: Dr. K. Tomimasu.

Assistant Professor: Dr. H. Niino.

*Oceanographical Laboratory:*

Assistant Professor: Dr. H. Niino.

*Zoological Laboratory:*

Professors: A. Terao, D.Sc., J. Hori.

Assistant Professors: K. Ebina, Dr. T. Mimura, Dr. D. Inaba, K. Matsubara.

*Botanical Laboratory:*

Professors: D. Higashi, Dr. S. Ueda.

Instructor: Dr. K. Onda.

*Bacteriological Laboratory:*

Assistant Professor: M. Kimata.

Instructor: Y. Toyama, D.Agr.

*Economical Laboratory:*

Professors: Dr. M. Habara, S. Azimi, T.

Miura, Dr. A. Kuragami, Dr. S. Katayanagi,

Dr. S. Tanahashi, F. Katayama, Y. Koishi.

Assistant professor: Dr. S. Okamoto.

Instructor: Y. Honiden, Dr. Eco.

Experts: J. Nakagawa, Y. Ito, M. Shibato.

**Pelagic Fishery:**

Professor: T. Tajima.

Several other educational associates and maintenance and operation workers.

*Provision for visiting investigators:* None.

*Income:* Temporary annual about 400,000 yen, from the Government.

*Provisions for publication of results:* Journal of the Imperial Fisheries Institute, (both in Japanese, "Suisan Kôsyûzyo Kemkyû Hôkoku," and in European languages).

### **Hydrographic Department of the Imperial Japanese Navy ('37)**

*History or origin:* Established in 1871, first under the War Department as the Naval Hydrographic Bureau, transferred in 1872 to the Navy Department which was established during that year.

*Location:* Tokyo.

*Organization to which attached:* The Imperial Japanese Navy.

*Purposes:* The Hydrographic Department conducts the preparation and issue of hydrographic and aeronautical publications, undertakes the survey of coasts and seas, makes recommendations and issues notices regarding safety of navigation, and educates hydrographic experts and their assistants. It also conducts for the Navy observations, researches, and study of marine-meteorological and oceanographical phenomena.

*Scope of activities:* The Department is divided into six sections, namely, the First, the Second, the Third, the Fourth, the Fifth, and the Accounts.

The First Division conducts business connected with the following:

1. Planning the preparation of hydrographic and aeronautical charts and books.
2. Planning hydrographic surveys, meteorological and oceanographical observations.
3. Compilation of hydrographic and aeronautical publications with the exception of those concerning magnetism, astronomy, tides, meteorology, and oceanography.
4. Notices to Mariners and Notices to Aviators (for correction and supplementing aeronautical documents).

The Second Division conducts business connected with the following:

1. Actual conduct of hydrographic surveys.
2. Preparation of original charts and hydrographic accounts.

3. Compilation of publications bearing on terrestrial magnetism.

4. Technical education of the hydrographic experts and assistants engaged in surveying work.

The Third Division conducts business connected with the following:

1. Compilation of hydrographic and aeronautical charts.
2. Drawing of charts, preparation of plates, and printing.
3. Technical education of personnel engaged in the foregoing works.
4. Correction and supplementing of original plates and of publications in the custody of the Section.
5. Provision, supply, exchange, distribution, and contribution, lending custody, and taking in and out of publications.
6. Sale of publications.

The Fourth Division conducts business connected with the following:

1. Compilation of publications bearing on nautical astronomy and tides.
2. The technical education of the personnel engaged in astronomical and tidal calculation.

The Fifth Division conducts business connected with the following:

1. Actual conduct of marine meteorological and oceanographical observations.
2. Researches and study of marine-meteorological and oceanographical phenomena.
3. Compilation of publications bearing on the foregoing phenomena.
4. Technical education of the personnel engaged in the foregoing observations.

The Accounts Section conducts business connected with the following:

1. Revenue and expenditure.
2. Purchase and sale of office supplies.
3. Receipt, custody, and delivery of office supplies.
4. Correspondence and transportation.

#### *Equipment:*

SURVEYING VESSELS	OFFICERS AND CREW	
	DISPLACEMENT	
KOMAHASI.....	1,688	128
KÔSYÛ.....	2,270	102
YODO.....	1,450	182

*Staff:* Chief Hydrographer, Kaigun Syôsyô (Rear-Admiral) Tomisaburô Ôtagaki.

Head of 1st Section (General Affairs; investigation; projection and compilation) Kaigun Taisa (Captain) Sadakiti Sitabô.

Head of 2nd Section (Surveys) Kaigun Taisa (Captain) Kanzô Matubara.

Head of 3rd Section (Cartography and Publications) Kaigun Taisa (Captain) Kiyosi Kusakawa.

Head of 4th Section (Astronomical Calculations, research and prediction of Tide), Kaigun Taisa (Captain) Tosio Akiyosi, B.Sc.

Head of 5th Section (Marine Meteorology and Oceanography) Kaigun Taisa (Captain) Sohei Tasiro.

Head of Section of Accounts Kaigun Syukei-Tyûsa (Paymaster Commander) Gonzô Tokida.

*Provisions for visiting investigators:* No special accommodations for visitors.

*Income:* Estimated expenditures in 1936: Yen 1,113,000.

*Provision for publication of results:* Notices to Mariners, Translation of Foreign Sailing Directions, Sailing Directions for Japan, The Russian Maritime Provinces, and the China Pilot. These together with those for Bengal, Philippine Islands, Borneo, the western and eastern sides of the China Sea, and most parts of Eastern Archipelago and Hawaii, 55 volumes; Ocean Passages, 1 vol., Coastal Passages, 1 vol.; the Light Lists for Japan and other parts of the Orient, 2 vols.; separate volumes of sailing directions for various maritime regulations, Tide-tables, Nautical Almanac, Astronomical Navigation Tables, Distance Tables, List of Japanese Place Names, Hydrographic Bulletin (Suiro-Yoho), Bulletin of the Hydrographic Department Imperial Japanese Navy of which eight volumes have been issued (being irregular reports of studies and investigations).

#### Central Meteorological Observatory of Japan ('37)

*History or origin:* Established in 1875.

*Location:* Takehira-tyo 2, Kozimatiku, Tokyo.

*Organization to which attached:* Department of Education.

*Purposes:* General meteorological investigations including allied researches in oceanography, seismology, and terrestrial magnetism.

*Scope of activities:* (1) Forecasting weather and printing weather charts. (2) Radio reception and sending of weather reports. (3) Work shops where instruments are made. (4) Repairing chronometers. (5) Solar radiation and its in-

fluence on plankton. (6) Tidal investigations. (7) Seismology. (8) Terrestrial magnetic observations.

*Equipment:* M. S. RYOHU-MARU, a steel boat of 1,200 tonnage, specially intended for the marine meteorological and oceanographical observations, is in course of construction, and will be completed in June, 1937. Principal dimensions: length 225 feet, breadth 35 feet, depth 24 feet. Twin screws. Speed: 15 knots.

*Staff:* Director Prof. T. Okada; Chief of the Forecast Division, Dr. S. Fujiwhara; Chief of the Tides and Radiation, Dr. R. Sekiguti.

*Income:* Yen 750,000 (annual).

*Provision for publication of results:* Monthly and annual reports of Meteorological Observations in Japan; Monthly Weather Review; Geophysical Magazine; Bulletin; Actinometric Bulletin; Solar Radiation; Tide tables—Short Report of results of observations on solar radiation made in Japan. Report of Magnetic Observations; Report of Agricultural Meteorology; Report of Aerological Meteorology.

#### The Fisheries Experiment Station of the Government-General of Chosen ('37)

*History or origin:* Established on May 6, 1921.

*Location:* Fusan, Chosen.

*Organization to which attached:* The Government-General of Chosen.

*Purposes:* Scientific researches on aquatic products for the promotion of the Fisheries.

*Scope of activities:* Chosen and its adjacent waters.

*Equipment:* Main building in Fusan consists of laboratories for (a) fishing research and the study of suitable fishing boats, (b) chemical and physiological researches, (c) biological and aquicultural researches and (d) oceanographical researches.

Research vessels: (a) MISAGO-MARU, a steel motor boat of 153 tons for oceanographical observation, (b) OTORI-MARU, a wooden motor boat of 40 tons and (c) HAYABUSA-MARU, a wooden motor boat of 31 tons, both for fishing researches.

Branch Station at Chinkai for fish culture has (a) biological laboratory and (b) ponds for fresh water fish culture.

Branch Station at Seishin for manufacturing industry of Sardine has (a) chemical laboratory and (b) factories.

*Staff:* Head of the fishery department.

Head of the chemical and physiological department.

Head of the biological and aquicultural department.

Head of the oceanographical department.

*Provisions for visiting investigators:* No provision.

*Income:* 6,000 yen.

*Provision for publication of results:* Bulletin of the Fishery Experiment Station of the Government-General of Chosen, and other journals.

## JAVA TO STRAITS SETTLEMENTS, INCLUSIVE

### EAST INDIES

#### Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia ('37)

*History or origin:* Established in 1866.

*Location:* Batavia, Java.

*Organization to which attached:* Netherlands East Indian Government.

*Purposes and scope of activities:* General meteorological and geophysical work. Also studies of sea water temperatures and other physical aspects of the sea.

*Equipment:* An excellent laboratory in Batavia in which there is all of the necessary apparatus for the conduct of the work within the scope of the observatory.

*Staff:* Director, Dr. J. Boerema; Dr. H. P. Berlage, Jr. Technical and clerical: 40. Maintenance and operation: 5.

*Provisions for visiting investigators:* Investigators can be accommodated.

*Income:* Sources: State.

Amount: f. 150,000 ('33).

*Provision for publication of results:* Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia, Verhandelingen. Yearbook, Seismol. Bulletin, Rainfall Observations.

#### Laboratorium voor het Onderzoek der Zee (Laboratory for Marine Investigations) ('37)

*History or origin:* Continuation of the former Fishery Station which was established in 1906 with the intention of carrying out investigations relating to sea-fishery problems. At present there is a separate fishery station and the new laboratory is intended for purely scientific sea-exploration and marine studies.

*Location:* Pasar ikan (fish-market), Batavia.

*Organization to which attached:* Belongs to 's Lands Plantentuin (Botanical Gardens), Buitenzorg.

*Purposes:* Scientific marine investigations.

*Scope of activities:* The former director, Dr. H. C. Delsman, worked mainly on pelagic fish eggs and larvae, and later on the plankton of the Java Sea; coral-reef studies have been made by Dr. Verwey; Doctor Hardenberg has been occupied with the fish fauna of river mouths.

*Equipment:* A laboratory, a small public aquarium, both situated in a small botanical garden; possesses a motor-boat; an auxiliary aquarium on Isle of Onrust in Bay of Batavia; cruises in the Java Sea made on board a government steamer.

*Staff:* Acting Director Dr. J. D. F. Hardenberg, biologist. European waiter and servants attached to the laboratory.

*Provisions for visiting investigators:* One room in the laboratory, with about 5 working-places, is reserved for visiting investigators. These places are free.

*Income:* All costs are paid by the government. The available sum has been greatly reduced.

*Provision for publication of results:* Results are published in "Treubia" the zoological periodical of the Botanical Gardens.

### NEW ZEALAND

#### Porto Bello Marine Fisheries Investigation Station ('34)

*History or origin:* Establishment of the station was first undertaken by the Otago Institute and was effected by means of funds raised by scientific societies and the New Zealand Government. It was formally opened in 1904.

*Location:* Near Dunedin on Otago Harbor.

*Organization to which attached:* Associated with the marine fisheries investigation of the Marine Department of New Zealand.

*Purposes:* To study the problems of significance to New Zealand fisheries.

*Scope of activities:* Biological investigations, especially those of economic significance, of considerable range, and local hydrographic work, especially water temperatures and local currents.

*Equipment:* Indoor aquarium and large outside ponds; laboratory and library; fishing launch and gear; residences for staff.

*Staff:* Chairman of the Board, Prof. W. B. Benham. There is at present no residential biologist. The Station is under the care of Mr. W. Adams.

The Station is under the control of a Board appointed by the Government. The members are: Prof. W. B. Benham; Dr. Church; Mr. L. D.

Coombs; Mr. A. E. Hefford; Prof. J. Malcolm; Mr. J. McG. Wilkie; Mr. C. A. Wilson; Mr. W. George Howes, in charge of Station and its activities. Also acting as Honorary Secretary and Treasurer. Technical and clerical: 1.

*Provisions for visiting investigators:* Some investigators can be accommodated, subject to arrangements made through the Hon. Secretary.

*Income:* Sources: There is a grant from the Marine Department of New Zealand, New Zealand Government.

Amount: £300 per annum.

*Provision for publication of results:* Various scientific publications, especially New Zealand.

#### PHILIPPINE ISLANDS

##### Bureau of Science, Philippine Islands ('37)

*History or origin:* Established in 1901.

*Location:* Manila.

*Organization to which attached:* The Department of Agriculture and Natural Resources.

*Purposes and scope of activities:* Routine work in making chemical analyses, tests, and estimations of several different kinds; the identification of plants, animals, and minerals; manufacture of vaccines and serums; and several kinds of research. The fields of research include medical biology, botany, organic chemistry, inorganic chemistry, soils and fertilizers, geology and mines, food preservation, malaria and mosquito studies, and participation in the United States Army Medical Department Research Board. There is under the Bureau of Science a section of fisheries, and in the past, several members of the staff, including the paleontologist and those connected with the fishery section, were active in certain kinds of oceanographic work.

*Equipment:* Offices and well-equipped laboratories for work of the kinds listed above.

*Staff:* Director, Angel S. Arguelles. A staff with specialists for each kind of work.

*Income:* From the Philippine Government.

*Provision for the publication of results:* The Philippine Journal of Science (monthly), Monographs (occasional), Popular Bulletin (Occasional), Mineral Resources, Annual Report.

##### Coast and Geodetic Survey ('37)

*History or origin:* Established in 1901.

*Location:* Central office in Manila.

*Organization to which attached:* Philippine Govern-

ment and the United States Coast and Geodetic Survey.

*Purposes and scope of activities:* Hydrographic and topographic surveys and the preparation of nautical charts and air-way maps in the Philippine Islands, and the study of tides, currents, and oceanographic conditions in Philippine waters.

*Equipment:* Offices and surveying vessels. An office and printing presses are maintained in Manila. In 1936 the vessel FATHOMETER was in active service.

*Staff:* Officers of the Coast and Geodetic Survey are assigned by the director of the organization in Washington, D. C., for work in the Philippines. The Director of the Coast and Geodetic Survey for the Philippine Islands in 1936 was Captain T. J. Maher, U.S.C. and G.S.

*Income:* Source: From the Government of the United States and the Government of the Philippine Islands.

Amount: For the year 1932 the total amount was 736,996 Filipino pesos.

*Provisions for the publication of results:* The charts of the Philippines are published by the Coast and Geodetic Survey in Manila, and the Coast Pilot of the Philippine Islands is published in the United States. A revised bathymetric chart of the Philippines is published in Publ. Manila Observatory, vol. 3, illustrating art. no. 8, 1931.

##### Fish and Game Administration ('37)

*History or origin:* Originally this was merely a section in the Biological Laboratory of the Philippine Bureau of Science and continued to be so until 1920 when it became the Division of Fisheries. The present institution was created February 1, 1933, independent of the Bureau of Science by virtue of Memorandum Order No. 6 of the Department of Agriculture and Commerce from the consolidation of the activities of the Divisions of Fisheries and Zoology of the Bureau of Science and the Division of Forest Fauna and Grazing of the Bureau of Forestry.

*Location:* Bureau of Science Building, Manila, P. I.

*Organization to which attached:* Department of Agriculture and Commerce, Government of the Philippine Islands.

*Purposes:* For scientific and economic research work relative to the fishes, sponges, and other aquatic resources of the Philippine Islands; for the diffusion of knowledge among the fishermen of the Philippine Islands; for the study, improvement,

propagation of the fishes and aquatic resources most suitable for Philippine waters; for the establishment, maintenance, and operation of experimental stations, farms, aquariums, and fish culture laboratories; for giving practical instruction in the culture of fishes and other aquatic resources, in the most economic and efficient manner of fishing, in the preservation of fish and other aquatic products, in the management of fisheries and canneries; and for all other purposes the object of which shall be to foster, propagate, and protect fishes, shells, sponges, and other aquatic resources of the Philippine Islands.

*Scope of activities:* Dissemination, through correspondence and interviews, of information pertaining to fish culture, fish preservation and fishing methods; preparation of indorsements, regulatory measures and other important matters of the kind; care of the collections of fishes, reptiles, batrachians, birds, crustaceans, mollusks, and insects; systematic studies in the laboratory based upon the above collections; recording and identification of specimens in the above collections; operation of the propagation ponds in the Bureau of Science grounds; maintenance of the experimental fish farm at Hinigaran, Occidental Negros; management of the aquarium; preparation and maintenance of exhibits in all classes of zoology pertaining to work; field investigations on fishery resources and industries, on the migratory, spawning, and feeding habits of fishes and other aquatic animals, and on their distribution and abundance; oceanographic work as time and facilities permit; preparation of papers for publication on research work conducted in the field and in the laboratory; issuance of hunting and fishing licenses; gathering of statistical data relative to commercial fisheries; enforcement of laws and regulations for the protection of fish and game.

*Equipment:* Working collections of fishes, reptiles, batrachians, birds, crustaceans, mollusks, and insects. Motor launch SCIENCE I, about 30 tons gross, is used for survey and extension work.

Laboratory facilities.

Bureau of Science Library.

*Staff:* Scientific: Hilario A. Roxas, Chief, Fish and Game Administration; Deogracias V. Villadolid; Heraclio R. Montalban; Florencio Talavera; Canuto A. Manuel; Jose R. Montilla; Claro Martin; Guillermo Ablan; Agustin Umali. Tech-

nical and clerical: 30. Maintenance and Operation: 21.

*Provisions for visiting investigators:* Accommodation and facilities in the laboratory, access to the collections, use of the library, company of members of the scientific staff in field investigations.

*Income:* Fees authorized to be collected under insular fisheries of Fisheries Act No. 4003, and under Act No. 4005.

About P100,000.00.

*Provision for publication of results:* Scientific and technical papers are published in the Philippine Journal of Science.

### Manila Observatory ('37)

*History or origin:* Founded in 1865 as Meteorological Observatory.

*Location:* Manila.

*Organization to which attached:* Philippine Jesuit Mission. Coöperation with Department of Agriculture and Natural Resources of the Philippine Islands.

*Purposes:* Meteorology, astronomy, seismology, and magnetism.

*Scope of activities:* Observation and research. The Manila Observatory is not an oceanographic institution and has no means nor equipment to conduct any oceanographic research. It does, however, coöperate with other scientific institutions of the Philippines in the compilation of observations that may prove of value to professional oceanographers.

*Equipment:* Meteorological, seismic, astronomical, and magnetic instruments.

*Staff:* Scientific: Rev. Miguel Selga, S. J., Director; Rev. Charles E. Deppermann, S. J.; Rev. William C. Repetti, S. J.; Rev. Francis J. Heyden, S. J.; Rev. Bernard F. Doucette, S. J. Technical: 5. Maintenance and operation: 4.

*Provisions for visiting investigators:* None.

*Income:* Sources: Government appropriation.

Amount: Variable as per annual budget.

*Provision for publication of results:* "Publications of the Manila Observatory," of which volume 3 is devoted to a series of oceanographic papers, consisting of 10 numbers, published in 1931, a report of the Philippine "Weather Bureau, Manila Central Observatory," is entitled, "Weather Observations from Ships for the year 1930" published in 1932. This report is published in compliance with an arrangement entered into by the directors of the Far Eastern Weather Service.

**Puerto Galera Marine Biological Laboratory of the University of the Philippines ('37)**

*History or origin:* Through the request of Dr. Lawrence D. Griffin, President of the University, Dr. Murray Bartlett, entered into an agreement with Dr. R. P. Strong of the Bureau of Science to send a joint expedition to undertake a marine biological survey of the Philippine waters. The first place visited was Puerto Galera, Mindoro, and a temporary station was established at this place in 1912. In 1924, the Board of Regents granted the Departments of Zoology and Botany authority to conduct yearly six weeks of field work for the purpose of giving summer courses.

*Location:* Municipality of Puerto Galera, extreme northern point of Island of Mindoro (long. 120° 58' E., lat. 13° 31' N.), about 89 nautical miles from Manila, 16 nautical miles from Batangas, 17 nautical miles from Bauan, Batangas, and 18 nautical miles from Calapan, the capitol of the province of Mindoro. The station is best accessible from Bauan or Batangas where motor- and sail-boats can easily be chartered. The University usually makes special arrangements with the several inter-island steamship companies of Manila to take its equipment, supplies, and personnel yearly direct from Manila to Puerto Galera.

*Organization to which attached:* The University of the Philippines.

*Purposes:* To provide biologists of the Philippines and other countries place and equipment for carrying out investigations on marine animals and plants.

*Scope of activities:* Investigations of purely biological problems on general physiology, embryology, animal behavior, ecology, experimental biology and systematics, and to study other problems of direct economic importance; to gather more data on the habitats, life-histories, natural enemies, food, et cetera, of the known edible animals.

*Equipment:* The laboratory building is equipped with laboratory tables, light, tanks for fresh and sea water, chemicals, and books, as well as other necessary apparatus. During summer session (April and May) the visitors may take their meals in the mess (\$30.00 a month) and rent a small hut (\$5.00 a month) (Philippine pesos). During other months, investigators have to bring their own provisions and rent a small house. An investigator is provided by the station with microscope, chemicals, and other facilities com-

mon to scientific undertakings. However, any visiting investigator may bring his own apparatus necessary for the performance of his particular line of research.

*Staff:* Scientific: Hilario A. Roxas, Director; Leopoldo S. Clemente; Felix V. Santos; Amado T. Feliciano; Jose S. Domantay; Miss Lucia A. Manikis; Miss Angela de la Paz; Jose V. Pay-Chiongco. Technical and clerical: 4. Maintenance and operation: 5.

*Provision for visiting investigators:* Every visiting investigator is welcome in this laboratory station. The visitor to Puerto Galera may take the train from Manila to Batangas and may take a boat from Batangas to Puerto Galera. The trip from Manila to the place of the station may take ten hours.

*Income:* The station has no fixed appropriation, but obtains its necessary running expenses both from the College of Liberal Arts and the Summer School.

*Provision for publication of results:* Results of work done in this station may be published either in the U. P. Natural and Applied Sciences or in the Philippine Journal of Science.

SIAM

**Krom Uthoksat (Hydrographic Service of the Royal Siamese Navy) ('37)**

*History or origin:* The present Hydrographic Service was formerly a mere Depot of Charts and Instruments intended for the Navy. The difficulties that were experienced in maintaining an adequate supply of charts, all of which were purchased from foreign countries, early led to a recommendation from the Naval General Staff that means for providing charts should be installed at the depot. It also became apparent that charts should be constructed by the Siamese in their own country.

The survey work in Siamese waters was begun in the year 1856 by Master John Richards, R.B.N., with the assistance of Mr. G. H. Inskip and Mr. J. W. Reed, R.B.N., on board H.B.M.S. SARACEN. After that time there were many foreign surveying parties in different parts of the Siamese waters. The hydrographic work in the Siamese Navy was initiated in 1908, and in 1913 a Hydrographic Office was created under the administration of the Naval Science Department. Up to 1912 Danish Naval officers were the instructors and chiefs of surveying. In 1914 two survey divisions were formed

and directed by Danish officers. In 1915 both survey divisions were directed by Siamese naval officers, but until 1926 the work was under the general supervision of a Danish officer. Although the survey of Siamese waters has been carried on for more than 50 years, it was not until the present century that it became necessary to concentrate the work under the management of a special authority.

After the Siamese Navy undertook the surveys in the Siamese waters, it was the practice to send the working charts to Copenhagen for final draughting and reproduction. The first sheet was published in 1914. In 1915 two Siamese officers were sent to Denmark, where they were attached to the survey work of the Hydrographic Department (Søkart Arkevet, Copenhagen) to study drawing and the construction of charts. Upon their return to Siam in 1917 a school to instruct students in the art of chart drawing and chart reproduction was established at the Hydrographic Office. In 1921 the first chart was printed in Siam. Now the Hydrographic Service has charge of all construction and publication of charts.

In 1929 the Siamese Navy sent two of its officers to the United States to study hydrography and such allied subjects as geodesy, tide harmonic analysis, oceanography, meteorology, modern information, and instruments of this branch in U. S. Navy, and they visited the International Hydrographic Bureau. In 1932 the officers came back and with their chief set to work to remodel the organization of the office so as to cope, technically and financially, with the awkward situation caused by the general depression.

*Location:* Bangkok.

*Organization to which attached:* Siamese Navy.

*Purposes:* To collect, digest, and issue timely information calculated to afford the maximum possible navigational safety and facility to the ships on the seas or to mariners on the whole.

*Scope of activities:* There are sections as follows:

Administration, Marine survey and chart construction, Lights and beacons, Maritime security, Oceanography, and Meteorology.

*Equipment:*

SURVEYING VESSELS	DISPLACEMENT	OFFICERS	CREW
PAL . . . . .	597	6	56
GUT . . . . .	597	6	56

*Staff:* Director, Nai Nava Ek (Captain-Capitaine de Vaisseau) Luang Samruat Vithin Smudh.

Asst. Director, Nai Nava Tho (Comm<sup>r</sup>-Capitaine de Fregate) Luang Joldhan Brudhikrai.

Chief of Section of Marine Survey and Chart Construction, Nai Nava Tri (Lt. Comm<sup>r</sup>-Capitaine de Corvette) Luang Subhi Utakdhan.

Chief of Section of Lights and Beacons, Nai Nava Tri (Lt. Comm<sup>r</sup>-Cap. de Corvette) Luang Cholasückseni.

Chief of Section of Maritime Security, Nai Nava Tri (Lt. Comm<sup>r</sup>-Cap. de Corvette) Luang Pichywari.

Chief of Section of Oceanography, Nai Nava Tri (Lt. Comm<sup>r</sup>-Cap. de Corvette) Luang Thien Cholatpratheep.

Chief of Section of Meteorology, Nai Rua Ek. (Lt.-Lt. de Vaisseau) Charoon Bunnag.

*Provisions for visiting investigators:* Nothing special.

*Income:* The budgets of the Hydrographic Service from the years of 1921 were as follows:

YEARS	AMOUNT Ticals	YEARS	AMOUNT Ticals
1921	203,342	1930	176,180
1922	253,790	1931	199,400
1923	248,424	1932	146,432
1924	257,399	1933	146,202
1925	244,224	1934	177,833
1926	194,045	1935	235,920
1927	194,019	1936	219,103
1928	178,666	1937	Data are not available
1929	190,289		

*Provisions for publication of results:* Charts, "Siamese Notice to Mariners" (since 1920 in both Siamese and English). "List of Lights in Siamese Waters", "Bangkok Bar Tide Tables", "Catalogue of Siamese Charts", "Distance Table in Siamese Waters" and "Year Books".

## SIBERIA

### The Kamchatka Fisheries Station ('35)

*Location:* Petropavlovsk, Avatcha Bay, Kamchatka.

*Organization to which attached:* The All-Union Scientific Research Institution of Marine Fisheries and Oceanography.

*Purposes:* To study comprehensively and in detail the waters adjacent to the Kamchatka Peninsula.

*Scope of activities:* The site of the station is very advantageous for making stationary observations in great depths in the open ocean. Within a few tens of miles from Avatcha Bay, the depths of

the open ocean exceeds 4000 meters. The sea remains in this region, free of ice during the entire winter. Preliminary explorations made in 1932 near the station have revealed a large benthonic fauna. As soon as the new vessel now under construction, has been put into commission, it will make a regular passage four times a year on the latitude of Avatcha Bay. This station since 1932 has conducted oceanographic and biological researches jointly with the Kamchatka section of the Pacific Scientific Institute of Fisheries. The latter institute is especially occupied with the study of the supply of commercial fishes of the Kamchatka region.

*Equipment:* The station owns a motor boat of the Japanese type (Kawasaki) equipped for work to a depth of 300 meters. The construction of a motor vessel of 166 tons displacement, to work to a depth of 4000 meters is underway. The station also uses fishery trawlers.

*Staff:* Director, P. Ushakov; Senior Specialist Hydrologist, K. Vinogradov; Junior Hydrologist, M. Beckman; Chemist, O. Fishman; Hydrologist, Streeshin.

#### **The Pacific Institute of Fisheries and Oceanography ('35)**

*History or origin:* August, 1925, established under the direction of Prof. K. M. Derjugin, owing to decline of Far East salmon fisheries.

*Location:* Six km. from Vladivostok, near Ussuri Bay (which is free from ice during winter).

*Organization to which attached:* The All-Union Scientific Research Institution of Marine Fisheries and Oceanography.

*Purposes:* Research in hydrology, hydrobiology of Japan, Okhotsk, Bering Seas, and rivers; study of fishes of those basins; investigation of Russian Far Eastern fisheries, propagation of fishes, especially salmon.

*Scope of activities:* Fishery division, hydrobiological division, fish culture.

*Equipment:* 1 large building which contains laboratories, museum, aquarium, library, rooms for specialists; 2 hatcheries at the disposal of the Station; 17 temporary field stations, research station; 1 motor boat.

*Staff:* 45 persons, scientific, technical, administrative.

*Provisions for visiting investigators:* Laboratory and

aquarium are free to all interested in marine biological and oceanographical research.

*Provision for the publication of results:* Hope to publish in near future (1926).

#### **STRAITS SETTLEMENT AND FEDERATED MALAY STATES**

#### **Department of Fisheries, Straits Settlements and Federated Malay States ('36)**

*History or origin:* For an account of the organization for the year 1931 see publication cited below.<sup>5</sup> Since then there have been further developments, but detailed information on them is not available. It was intended to establish a laboratory and aquarium and to acquire a vessel for work at sea.

*Location:* Singapore.

*Organization to which attached:* The Governments of the Straits Settlements and the Federated Malay States.

*Purpose:* Fisheries research.

*Scope of activities:* Statistics, imports and exports, fishery development (including preservation and marketing of fish), studies of the various economically valuable fish, shell-fish, and turtles. Oceanographic work as related to fisheries is planned.

*Equipment:* As stated above a laboratory, aquarium, and fishery-research vessel are planned.

*Staff:* Officer in charge, W. Birtwistle; Several fishery officers; Chief clerk and other clerks.

*Income:* For 1931, 60,029.31 Straits dollars, divided between the Straits Settlements and the Federated Malay States.

*Provisions for publication:* Annual reports, otherwise none.

#### **INSTITUTIONS ON THE RED SEA AND IN INDIA**

##### **EGYPT**

#### **The Marine Biological Station of the University of Egypt ('37)**

*History or origin:* Established in December, 1930.

*Location:* The name is given as "Hurghada" on maps. This is incorrect but better known to Europeans. On the edge of the shore reef 5 kilometers (3 miles) north of the camp of the Anglo Egyptian Oilfields, six miles from steamer piers. Ghardaqa is in Lat. 27° 16' N., south of the entrance to the Gulf of Suez, on the African side.

<sup>5</sup> Birtwistle, W., Annual Report on the Fisheries Department, Straits Settlements and Federated Malay States for the year 1931, pp. 37, Singapore, 1932.

*Organization to which attached:* The University of Egypt, subsidized by the State.

*Purposes:* (1) Research, biological in the wide sense including physiology and chemistry, coral reef problems, and oceanography.

(2) Instruction. It is proposed to give general instruction to senior students of the University and possibly to secondary school teachers.

*Scope of activities:* Physical, chemical, and biological oceanography of the Red Sea. As the Red Sea is still so imperfectly known biological exploration and the formation of a reference collection are likely to take a considerable amount of time in the next few years. For instance, to mention only the groups with which I have some acquaintance, new spp. of Polychaeta and a striking new coral have already appeared, though collecting has only just begun. Examination of living specimens of, e.g., the soft corals is likely to reform the systematics of several groups. The occurrence of *Syllis remosa* Mc.I. in shallow water in the Red Sea is another indication of the necessity for this preliminary survey.

*Equipment:* All buildings in wood and asbestos, single story. One laboratory of four rooms total, area 19 m x 5 m, and one sorting room, 6 m x 6 m, on reef edge, connected with shore by dry stone pier 150 m long and one additional store 6 m x 5 m on pier.

Office Building, 25 m x 5 m, containing 2 office rooms, director's workroom and large preparation room.

Three rest houses for research workers.

Bungalows for director, clerk, and engineer. Another has been added this year (1936) for a scientific assistant.

5 huts for sailors, drivers, etc.

2 garages, general store, 2 fuel stores, 1 net and boat store, workshop, and engine-house.

1 launch, open 35 ft. x 8 ft. 6 in., 32 hp. paraffin engine, with winch for nets, winch for water bottles, Lucas sounder, to work up to 500 fathoms. 1 sailing boat, 30 feet long, 2 dinghies, and 2 canoes.

There is no aquarium and nothing in the way of a public exhibition, the station being intended purely for research. An outside tank, 10 m x 2 m is set up on the seaward side of the laboratory and a windmill and pump will be added to it next spring. On failure of wind the electrically driven pump supplying the laboratory will also supply this tank.

*Library.* The library has now all the Red Sea and Indian Ocean expedition reports, monographs on Red Sea fauna, etc., and a large number of separate papers. A library building, museum, etc., are to be built next summer, offices also to be moved onto reef and the present office building used for work on the MABAHITH results. The new buildings will contain laboratories for Director and assistants, leaving the four original rooms entirely for visitors. The chemical laboratory will probably be moved to the shore building thus making five rooms for visitors.

*Staff:* Consists at present of Director Cyril Crossland, A. H. Gohar, Assistant, A. H. Nast second Assistant (temporary), clerk, storekeeper, mechanic, sailors, and drivers. A scientific assistant will soon be appointed, and a chemist of the Faculty of Science will undertake water analyses. An engineer is to be appointed soon. On completion of the station other scientific staff may be appointed, permanently or temporarily.

*Provisions for visiting investigators:* 4 visitors can be accommodated, or 6 with a little crowding.

*Income:* The station is on the budget of the University.

*Provision for the publication of results:* Publication of the results by the Government has been approved by the Finance, and details will be settled shortly.

*Supplementary note:*

A. The Red Sea affords the most northerly extension of the Indo-Pacific fauna. This station is, therefore, the most accessible point at which the coral and other faunas of the tropics of the old world can be studied. It is hoped that this will enable the University of Egypt to produce notable contributions to tropical ecology, et cetera, and coral reef problems, and also that European and American Universities will be able to assist in the wide field thus opened up.

B. The fauna in the immediate neighborhood of the station is extremely rich. There are three lines of coral reef between us and the open sea, separated by water of average depths of three, ten, and twenty fathoms. Outside is a large area 40 to 50 fathoms deep, the hundred fathom line being about 6 miles from the station. Reefs two or three hundred yards from the laboratory are as rich in corals as any I have seen elsewhere.

C. Having clear water right at the end of the jetty simplifies and cheapens the installation very

greatly. There is no need for the usual storage tanks and elaborate filters, so pure water can be supplied direct in unlimited quantities from the sea via a small delivery tank.

In order to have a pure water supply in the laboratory, and avoid the introduction of unknown quantities in experiments, the water will come into contact with no metal. The pump (electrically driven) is lined with stoneware, all pipes are of celluloid and the tank of concrete. Compressed air is also supplied. Gas for ovens, et cetera, is installed from Bubagas cylinders.

D. Each room is intended to be complete in itself, the storage of live specimens to be under the control of each worker; large specimens can be kept in the tank outside or in cages afloat in the harbor.

E. The station has the inestimable advantage of its own boat harbor in which apparatus, experimental or for storage of live stock, can be left secure from interference. This allows us to dispense with much of the tank and circulating water apparatus usually necessary, and makes possible experiments which cannot be undertaken in a public harbor.

F. The buildings are all of inexpensive construction, but visitors will find them perfectly comfortable at any time of the year. In a maritime climate insulation, however desirable, is entirely subordinate to movement of the air, and all buildings have been so placed that the wind can be admitted, to the extent desired, at all times. Further we are some hundred miles from the area of low pressure and high humidity which has given the Red Sea its reputation for unbearable heat in summer. I can testify to the difference from my own experience.

(Signed) C. Crossland

## INDIA

### Marine Survey Office, British India ('37)

*Location:* Bombay.

*Staff:* Surveyor in charge, Commander L. Sanderson, R. I. N.

Assistant surveyors, Lieut. Commander J. Ryland; Lieut. Comm. J. W. Jefford, R. I. N.

*Equipment:*

SURVEYING VESSEL	DISPLACEMENT	OFFICERS	CREW
INVESTIGATOR.....	1,985	6	108

### The Zoological Survey of India ('37)

*History of origin:* Established in 1916.

*Location:* The Indian Museum, Calcutta.

*Organization to which attached:* Government institute.

*Purposes:* The function of the Zoological Survey of India is to investigate the fauna of India and Indian Seas.

*Scope of activities:* Care and maintenance of the zoological and anthropological collections of the Government of India. The identification of specimens and the investigations of the ecology and bionomics of the Indian fauna. The maintenance of the zoological and anthropological galleries, open to the public, in the Indian Museum.

*Equipment:* The INVESTIGATOR, on the retirement of Maj. R. W. G., Hingston, I.M.S., from the post of Surgeon-Naturalist in 1926, ceased to carry out oceanographic work and marine investigations. The post of Surgeon-Naturalist, that had always been an Indian Medical Service appointment, was abolished and in its place the post of Naturalist to the Marine Survey of India was created and was embodied in the Zoological Survey of India, but owing to financial stringency this post has never been filled.

*Staff:* Dr. Bains Prashad, F.R.S.E., is the Director; 4 Assistant Superintendents (zoological); 1 Assistant Superintendent (anthropological); Naturalist to the Marine Survey of India (vacant).

*Provision for publication of results:* Records of the Indian Museum, Memoirs of the Indian Museum. Prior to its conversion into the Zoological Survey of India in 1916 this department formed the zoological and anthropological section of the Indian Museum and the trustees of the Indian Museum published a large number of comprehensive monographs dealing especially with the collections of the Marine Survey of India.

The following statement on the marine work of the Zoological Survey of India was made by Dr. Sunder Lal Hora:

The curators of the Museum of the Asiatic Society of Bengal, for example McClelland and Blyth, were mainly interested in the study of the freshwater and terrestrial fauna of India. With the establishment of the Indian Museum, and more especially after the creation of the post of the Surgeon-Naturalist, more and more

interest was taken in the study of the marine fauna of India, as well as in the real oceanographical work. The large number of monographs and reports published from the Indian Museum on the marine animals shows the extent of the faunistic work accomplished by the successive Surgeon-Naturalists; while Lt. Col. R. B. S. Sewell's oceanographic monographs in the *Memoirs of the Asiatic Society of Bengal* reveal extensive data collected over a number of years. Though a certain amount of faunistic work has been done by other individuals and institutions, the real oceanographical work has been done by the Surgeon-Naturalists on board the INVESTIGATOR.

Since the establishment of the Zoological Survey of India in 1916 attention, apart from the work of successive Surgeon-Naturalists, has been paid mainly to the freshwater and terrestrial fauna of India. Dr. S. W. Kemp, however, made large collections of marine animals in the Andamans, and at Goa, Kilakarai, Madras, and Vizagapatam in India. Other members of the Survey have also made collections at Karachi, Puri, Vizagapatam, Tuticorin, Krusadai, and the Andamans. The results of these investigations are embodied in a number of papers by several authors.

The late Dr. N. Annandale and Dr. S. W. Kemp started observations on the peculiar fauna that is found in the estuarine and brackish waters of India. As early as 1907, Annandale began to describe the fauna of the brackish pools at Port Canning. Kemp's account of the fauna of the Matlah River is of special interest in this connection. Both Annandale and Kemp made a comprehensive survey of the Chilka Lake, a large stretch of brackish water, and showed the adaptability of animals to withstand a great variation in the range of salinity. To compare his results with other similar lakes in Asia, Annandale made a tour of the Far East and studied the fauna and the conditions governing animal life in Tale Sap, Siam, Lake Biwa in Japan, and Lake Tai Hu in China. Other members of the Zoological Survey of India have studied the fauna of the Salt Lakes, Calcutta, and of the Cochin Backwaters with interesting results. Most of the work of the Survey is of a systematic nature, but extensive biological and ecological observations were made in all cases, though in no case were up-to-date limnological

investigations carried out. Mention may also be made of the valuable collections from the Sandheads received from the Pilot Service.

Recently, valuable *Trochus* and *Turbo* beds were found in the Andamans, and to establish the fisheries on a proper scientific basis an officer of the Zoological Survey has been put in charge of these fisheries. Besides his usual work in connection with the fisheries this officer and his assistant make collections of the marine animals. The results obtained so far have been extremely valuable.

For a number of years the Zoological Survey has been feeling very keenly the necessity of a marine biological station in Indian waters. Proposals were submitted to the Government for establishing a station at Port Blair in the Andamans, but without any success. Later a station at Karachi was suggested with a view to train young men from the universities as well as to look after the coastal fisheries, but the scheme is held up for financial reasons. There is, however, a small marine laboratory of the Madras Fisheries Department at Krusadai and at present efforts are being made to have a marine biological station at Bombay.

#### Ennur Biological Station ('37)

*History or origin:* Opened in 1921 by the Madras Fisheries Department for the supply of biological specimens to schools and colleges.

*Location:* On the sea-front close to a back-water about 18 miles north of Madras on the Madras and Southern Maharatta Railway.

*Organization to which attached:* Madras Fisheries Department.

*Purpose:* Supply of biological specimens to museums, colleges and schools, and aiding research workers by procuring collections for them.

*Scope of activities:* Preparation of museum exhibits, collection tours.

*Equipment:* 1 laboratory; 1 boat; edible oyster beds in the Ennur back-water, in the Pulicat lake, and at Gokulapalle.

*Staff:* Technical: Mr. S. Ramaswami Ayyangar, Research Assistant; Mr. B. Fraser, Laboratory assistant. Maintenance: 1 fieldman.

*Provision for visiting investigators:* Three seats.

*Income:* Source: Sale of zoological specimens. Amount: About Rs 2,000 annually.

*Provision for publication of results:* In the publications of the Madras Fisheries Department.

**Krusadai Biological Station ('37)**

*History or origin:* Krusadai Island was acquired in 1916 from the Rajah of Ramnad by the Government to serve as a Biological Station.

*Location:* Krusadai Island in the Gulf of Mannar, close to Pamban Railway Station on the Indo-Ceylon Railway.

*Organization to which attached:* Madras Fisheries Department.

*Purpose:* Fishery research with special reference to Pearl and Chank Fisheries.

*Scope of activities:* Collection and analysis of plankton, collection of data regarding various economic fisheries of the neighborhood, collection and identification of various food fish, the maintenance of a daily record of hydrographical observations including the collection of surface samples of sea water, studies of live fish and other marine organisms, pearl fishery research, studies of chanos culture.

*Equipment:* Laboratory, aquarium tanks, two fish ponds for cultivating *Gambusia* (Barbadoes Millions), a mosquito larvecidal fish; 1 boat; 1 canoe.

*Staff:* Assistant Biologist, Dr. D. W. Devanesan, M.A., Ph.D., D.I.C.; Research Assistant, S. T. Varadarajan, M.A.; 1 laboratory attendant; 2 boatmen.

*Provision for visiting investigators:* Six places.

**The Madras Aquarium ('37)**

*History or origin:* Opened on October 21, 1909.

*Location:* Sandy sea beach (Marina Beach), near the Presidency College, Madras.

*Organization to which attached:* Madras Fisheries Department.

*Purpose:* To provide amusement to the public; to study the habits of live sea-fish.

*Scope of activities:* Exhibiting live-fish in Aquaria; exhibiting delicate marine organisms such as hermit crabs, sea crabs, and sea-anemones; analysis of samples of sea-water.

*Equipment:* Aquaria for marine fishes supplied with sea-water from overhead tanks; a turtle pond; a gold fish pond; laboratory; restaurant.

*Staff:* Scientific: Director of Fisheries, Dr. B. Sundara Raj, M.A., Ph.D.; Assistant biologist; Dr. D. W. Devanesan, M.A., Ph.D., D.I.C.; Personal assistant to the director, Dr. M. Ramaswami Naidu, B.A., Ph.D.

Technical: Mr. M. K. Giriappa, laboratory assistant.

Maintenance: 3 keepers and one peon.

*Provision for visiting investigators:* Three seats.

*Income.* Source: Aquarium gate collections.

Amount: About Rs 7,000 per annum.

*Provision for publication of results:* In the publications of the Madras Fisheries Department.

**Madras Fisheries Department**

*History or origin:* In April, 1907, the Government accepted the proposal of Sir F. A. Nicholson for the initiation of a small Bureau of Fisheries for Madras.

*Location:* Madras Presidency (with Headquarters at Madras).

*Organization to which attached:* The Government of Madras.

*Purposes:* To introduce improved methods of fishing; to improve methods of manufacture in existing fishing industries, and to introduce new industries; and to work for the socio-economic betterment of the fishing population.

*Scope of activities:* Oceanographical research so far as it relates to the Department and administration of the Fisheries of the Madras Presidency.

*Equipment:* (1) Krusadai Fishery Research Station, Gulf of Manner. (2) West Hill Fishery Research Station, South Malabar. (3) Ennur Fisheries Station (near Madras) for supply of biological specimens. (4) Marine Aquarium (Madras) with a small Fishery Laboratory attached to it. (5) Library of Fishery Literature.

**Vessels:**

LADY NICHOLSON—motor schooner; built in 1913 at Calcutta; original cost Rs 115,000; gross tonnage 86 tons; 131 horse-power; speed 8.14 knots; length 107 feet, breadth 24 feet. Employed for the inspection of pearl-banks.

SEA SCOUT—motor launch; built in 1923 in England; original cost Rs 37,000; gross tonnage 20 tons; 40 horse-power, speed 8.66 knots; length 48 feet 6 inches, breadth 9 feet. Employed for towing pearl and chank fishing boats.

LEVERETT—motor launch; built in 1917 at Cochin; original cost Rs 7,000; gross tonnage 10 tons; 26-30 horse-power; speed 10 knots; length 28 feet 7 inches, breadth 8 feet. Employed for towing pearl and chank fishing boats.

PEARL—motor launch; built in 1909 by Dan Motor and Co., Ipswich; original cost Rs 3,847; gross tonnage 5 tons; 7 horse-power; speed 4.5 knots; length 25 feet 3 inches, breadth 7 feet 2 inches. Employed for towing pearl and chank fishing boats but at present disabled.

*Staff:* Director, Dr. B. Sundara Raj, M.A., Ph.D., Oceanography.

Assistant Biologist, Dr. D. W. Devanesan, M.A., Ph.D., D.I.C., Marine Zoology.

Personal Assistant to the Director of Fisheries, Dr. M. Ramaswamy Naidu, B.A., Ph.D., Oceanography.

*Provision for visiting investigators:* Three to six workers can be accommodated in each of the laboratories mentioned under Equipment.

*Income:* Sources: Fish curing yards, fishery rentals, pearl and chank fisheries, aquarium gate collections and zoological specimen supply, tanur productions, oyster supply, Nilgiri Fisheries, fishing license.

Amount: Rs. 380,500.

*Provision for publication of results:* Fish Statistics, Madras Fisheries Bulletin, Trawler's Reports, Bulletin on Marketable Fish, Bulletin on Pearl Fisheries, other publications relating to Madras Fisheries.

#### **Meteorological Department, Government of India ('34)**

*Location:* Central Office, Poona near Bombay.

*Organization to which attached:* Government of India.

*Staff:* Director-General of Observatories, Dr. C. W. B. Normand.

In the Indian Ocean the meteorological phenomena are of so great influence on the ocean that a memorandum entitled, "Brief Notes on Marine Meteorological Work undertaken by the Indian Meteorological Department" prepared by Doctor Normand is quoted in full. It is as follows:

#### *Storm Warning for Ports and Shipping:*

Whenever a storm or a disturbance exists in the Indian seas, suitable visual warning signals are hoisted at such ports on the coasts as are likely to be affected by the disturbance. The Meteorological Department keeps Port Officers supplied with the latest information with respect to all disturbances, and ships in port apply to them for information to supplement the storm signals. In addition to the regular ports on the west coast and on the Bay of Bengal there are some river ports and River Police Stations and a number of District Police Stations which have to be warned in connection with disturbed weather at the head of the Bay of Bengal. Of the ports on the Bay of Bengal some are provided with additional "locality signals" which indicate the particular areas in which weather

is disturbed. The details of these arrangements are described in this department's publication entitled, "Code of Storm Warning Signals for use at Indian Ports."

Shipping at sea is also supplied with the latest weather information by means of wireless bulletins, which briefly describe the position, development in intensity, probable movement of storms whenever any exist, or describe the general weather situation in the sea areas. The issues, which are ordinarily twice daily, are increased in disturbed or stormy weather to three or six times a day. When necessary, further messages are broadcasted at intervening times also. The radio stations at Bombay, Karachi, and Aden serve the Arabian Sea area, and those at Calcutta, Rangoon, and Madras serve the Bay of Bengal area; the wireless station at Matara serves both areas. The details of the arrangements for broadcasting meteorological bulletins to ships at sea and for ships to transmit by wireless their weather messages to the coastal radio stations are fully explained in this department's publication named, "Indian Ship's Weather Code."

The warnings to ports and shipping in the Arabian Sea against the approach of cyclonic storms, or of bad weather is done from the headquarters office at Poona, while similar warnings for disturbances in the Bay of Bengal are issued by the Meteorological Office at Alipore, Calcutta.

#### *Collection of Marine Meteorological data:*

Coded wireless weather messages from ships at sea constitute the chief source of marine data available for all purposes and, in supplement to the telegraphic observations from coast stations, they are essential in the maintenance of the warning system for ports and shipping at sea.

Another important source of marine meteorological data is the extracts from steamer's weather logs collected by the marine clerks of this department in Calcutta and Bombay, and sent from some steamers direct. Two log forms are in use—one for use during ordinary weather and the other, the pink form, for use during disturbed weather—and are designed to secure the collection of full marine meteorological data for purposes of later study. The port authorities at Rangoon also help in the collection of these extracts by allowing the observers of the Time Ball and Tidal Observatory of the Port Commissioners to copy or collect ship's weather logs. Occasionally, in special cases, logs of steamers with experience of disturbed weather are collected at Madras; and the Colombo Port

authorities also help this department similarly, when requested. The data thus obtained are entered on weather charts, and are used for reference in the storm-warning work of the department, in the preparation of accounts of the storms of the year for publication in the India Weather Review (Annual Summary), in the special studies of individual storms—their causes of development, movement, recurvature and dissipation—and for general climatological study of the Indian Sea areas. This work is being aided, slowly but steadily, by lending meteorological instruments to ships and by obtaining from the steamers meteorological logs and the readings of the instrument lent.

*Other non-recurring duties:*

In addition to the duties mentioned above, the department seeks generally to maintain contact with mercantile shipping interests. It has rendered all possible help in the marine meteorological training of the cadets of the I.M.M.T.S. DUFFERIN by examining the meteorological essays written by the cadets in meteorological subjects and by giving a meteorological prize annually to the best candidate, by preparing for the cadets weather chart exercises for Indian areas, and by occasional lectures on board the training ship on meteorological subjects. Meteorological data for Indian Sea areas are supplied whenever required to the International Meteorological Committee for their occasional International publications on marine meteorology and for preparing charts, et cetera, by them.

*Publications:*

From time to time the department has published atlases and books useful to those interested in marine meteorology, such as Eliot's "Handbook of Cyclonic Storms in the Bay of Bengal" and the "Cyclone Memoirs," pts. 1-5, and Dallas' "Meteorological Atlas of the Indian Seas." Some of the publications issued in recent years are:

1. Atlas of Storm Tracks in the Bay of Bengal—C. W. B. Normand.
2. Atlas of Storm Tracks in the Arabian Sea—C. W. B. Normand.
3. A brochure on Winds, Weather, and Currents on the coasts of India and the Laws of Storms—S. Basa.

Results of recent investigations on storms of the Indian seas have appeared in the following scientific articles:

Structure and Movement of Cyclones in the Indian Seas. S. C. Roy and A. K. Roy (Beitrage Zur Physik der Freien Atmosphere pp. 224-234, Vol. XVI, 1930).

*Scientific Notes.* Vol. III, No. 18. The structure of the Madras Storm of January 1929. K. R. Ramanathan and A. A. Narayana Aiyar.

*Scientific Notes.* Vol. III, No. 22. The Structure and Movement of a Storm in the Bay of Bengal during the period 13th to 19th November 1928. K. R. Ramanathan.

*Scientific Notes.* Vol. III, No. 29. The Bengal Cyclone of 1919. V. Doraiswamy Iyer.

*Scientific Notes.* Vol. IV, No. 34. A study of Two Premonsoon Storms in the Bay of Bengal and a Comparison of their structure with that of the Bay Storms in the Winter Months. K. R. Ramanathan and H. C. Banerji.

*Scientific Notes.* Vol. IV, No. 39. A study of the Structure of the Bay Storm of November 1926. Sobhag Mal and B. N. Desai.

Recent Investigations and Movement of Tropical Storms in Indian Seas—C. W. B. Normand. Gerlands Beiträge zur Geophysik, vol. 34, 1931, pp. 223-243.

**West Hill Biological Station ('37)**

*History or origin:* Opened in 1921 for marine fisheries research by the Madras Fisheries Department.

*Location:* Calicut, Malabar Coast.

*Organization to which attached:* Madras Fisheries Department.

*Purpose:* Fishery research and compilation of fishery statistics.

*Scope of activities:* Plankton investigation, sardine and other fishery investigations, hydrographical investigations.

*Equipment:* 1 laboratory; 1 canoe.

*Staff:* Scientific: Assistant Biologist, Dr. D. W. Devanesan, M.A., Ph.D., D.I.C.

Technical: Research Assistant, Mr. V. John, B.A.

Maintenance and operation: 1 peon, 1 watchman, 2 boatmen, 1 laboratory attendant.

*Provision for visiting investigators:* Three seats.

*Income:* Nil.

*Provision for publication of results:* In the publications of the Madras Fisheries Department.









